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April 3, 1930

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Engineering News-Record

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MACHINES OF CONSTRUCTION

Engineering construction operations are now measured in terms of machine output. Mechanization, the commanding development of the day, advances so fast the engineer is often at a loss to evaluate current changes. New machines appear. Old machines are resurrected by a new accessory. Familiar machines are improved. Like a moving picture, the development is rapid, kaleidoscopic. In this issue, the film is stopped on a selected cross-section of the construction machinery industry. A half-dozen authorities on the technology of this industry emphasize the development and present status of some important machines of construction. . . . . Their collective messages are stimulating and important.

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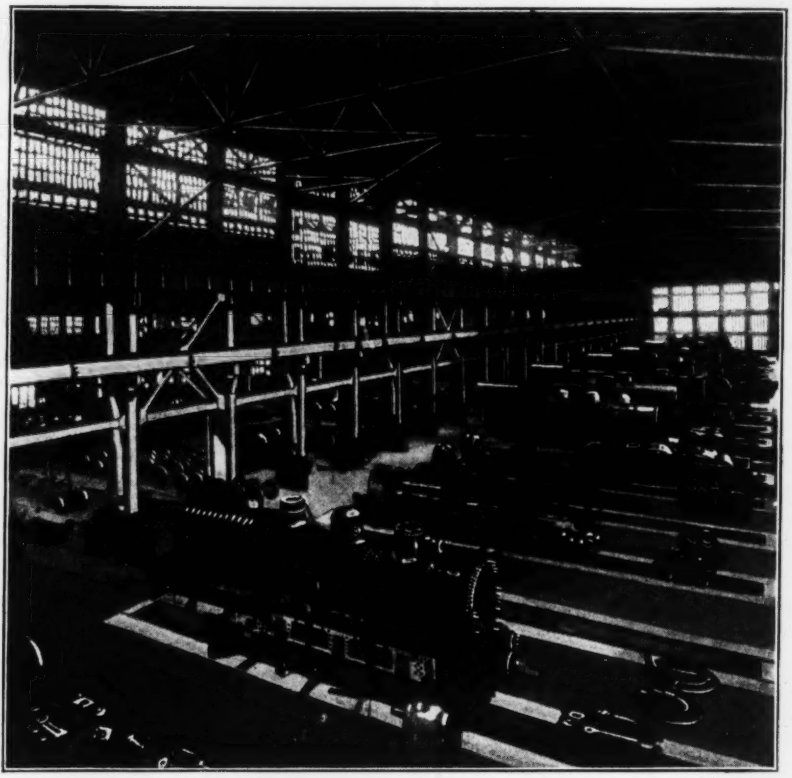

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Contents for April 3, 1930

VOLUME 104, NUMBER 14

Copyright, 1930, by McGraw-Hill Publishing Company, Inc.

The Pipe-Line Hydraulic Dredge 550
BY O. P. ERICKSON

Development of the Dragline Excavator 556
BY J. C. FRENCH

Weighing Hoppers and Scales 560
BY P. M. TEBBS

Hoist Progress From Single Drum to Seven 564
BY F. D. HOOPER

Portable Continuous Conveyors 569
BY W. B. GREENE

Elevating Grader and Crawler Wagons 573
BY S. F. BEATTY

Crawler Traction Revolutionizes Equipment Mobility 577
BY A. E. LODER

Handy Method for Unloading Shovel or Dragline 555
BY DARNALL BURKS

Gas-Fired Rivet Heaters on a New York Building 568

Alloy Steels Used in Locomotives 572

Special Parts Manufacture Improves Construction Machinery 576
BY KENNETH H. CONDIT

Special Truck for Survey Parties 581
BY WALTER STARKWEATHER

Editorial . 547 News . 582 Equipment . 588
Business News . 589 Prices . . 592 Unit Prices . 595

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CABLE ADDRESS: "MACHINIST, N. Y."

Published weekly. $5 per year. 25 cents per copy. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A.

Member A.B.C.
Member A.B.P.

NUMBER OF COPIES PRINTED THIS ISSUE, 32,014

NEW YORK District Office, 285 Madison Avenue
WASHINGTON, National Press Building
CHICAGO, 520 N. Michigan Avenue
PHILADELPHIA, 1600 Arch Street
CLEVELAND, Guardian Building
ST. LOUIS, Bell Telephone Building
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A McGRAW-HILL PUBLICATION — ESTABLISHED 1874

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, APRIL 3, 1930 Number 14

Present-Day Trends in Construction Equipment

Current Advance Characterized by Machine Refinement and Extension of Service Range

THIS ISSUE is devoted to articles on leading types of construction machinery, selected with a view to illustrating definite objectives toward which equipment engineering is progressing. Enough of the history of the various machines is told to co-ordinate the reader with the progress in improvement and with the developments in construction which have influenced progress. In forty pages examples of the equipment manufacturer's product in some of the major types of equipment are reviewed as to their evolution, and their latest forms are set forth and illustrated. Because the authors represent organizations long concerned in the production and use of construction machinery, their articles have that authority which commands interest and consideration. Thus the present issue constitutes a representative selection of the facts which demonstrate the vital part played by equipment engineering in modern construction and reflects its continuously growing importance.

INVENTION was the main characteristic of the early period of construction equipment development. Only many years later was attention centered on obtaining high mechanical development and extending the fields of use of the several types of machine. Few of the machines described in the following pages are new inventions, although some of them are new combinations of old devices. The weighing hopper used in batching concrete, for example, is an assemblage of old devices into a mechanism of very recent use in construction. Present activities in equipment development are essentially directed toward mechanical perfection and adaptation to broader use.

IN READING the history of how construction machines were evolved, it is instructive to note how some outstanding necessity has mothered machine invention. The building of the Chicago Drainage Canal—a work of the early nineties that was world renowned for its volume of earth and rock movement—gave birth to the dragline excavator, the slackline cableway excavator, the aerial dump for the taut-line cableway, and the belt conveyor as an earth-handling device. On that work the ore handler's tipple-incline and cantilever crane were converted into equipment for earth and rock excavation. And (let it be mentioned quietly in the presence of the recent return of the concrete tamper) the constructors of the Drainage Canal were the first large users of poured concrete and worthy and wordy fighters in its defense.

We are busy today with the development rather than the invention of equipment. The relatively crude inventions and applications of mechanisms which distinguished past decades are capable of remarkably wider ranges of use and higher level of performance through skilled engineering in design and production. For this reason the highest resources of mechanical ability are now being concentrated on equipment refinement and on the perfection of design and mechanism to extend the applications of equipment.

CONSTRUCTION equipment as it is represented in this issue exhibits two broad lines of development: machine refinement and extension of service. The first activity is more evident than is the second; yet, if carefully studied, the text and illustrations of the following pages show that constant and purposeful engineering thinking is being devoted to extending the possibilities of machine use. The fine power plant and control mechanism of the hydraulic dredge may be the first items to strike the eye; but simultaneously the diesel engine and the gyro-compass bring about a very important extension of the field in which the dredge can be used. The latter fact is less readily recognized because it must be deduced from knowledge of the drawbacks of servicing bulky fuel and the previous necessity of visible ranges to insure direction in operation.

In like manner the dragline excavator exemplifies a bold venture of the equipment engineer toward unprecedented size in an endeavor to extend the economic application of that machine. Again, the tractor-drawn elevating grader and crawler wagon combination is a purposeful undertaking to increase the limited productiveness of a number of machines operating independently by co-ordinating them into a machine train which multiplies production. Similarly the differentiation of the hoist fits it for wider economic service, and the crawler traction gives machines the mobility for use in more places.

Increased mobility and differentiation have been paralleled by improved control. This important function is, among the machines described, particularly evident in the hydraulic dredge and the construction hoist, but it will be found quite as prominently in the steering of the tractor crawler and the walking device of the 350-ton dragline excavator. An important element of this extension of machine control is that it contributes to safe operation. This is the essential purpose of some of the control devices of the modern hoist. In other instances added safety is an incidental contribution.

MODERN machine development represents an increasingly successful effort by equipment engineering to extend the service of machinery and to improve machine design and structure. Translated into terms of field service, the refinement of construction equipment and its differentiation for specific tasks is making possible a precision comparable to that of modern factory practice.

With this development there falls upon the constructor the exacting requirement of effective utilization of the tools that the equipment engineer is putting into his hands. Equipment improvement, in other words, creates the obligation of improved equipment management. Only intelligent selection, close co-ordination, adequate servicing and upkeep and skilled operation can succeed in realizing the full efficiency of construction.

Flatten the Equipment Market Peak

SEASONAL construction has created a seasonal market for construction equipment. Extended inquiry of equipment manufacturers and the plotting of their annual sales curves on the curve of construction contract awards discloses a close correspondence of the two. In general, seasonal demand affects all kinds of equipment. The sales peak is in April, May and June, the valley is in November, December and January. In February and March the curve rises sharply, and in July, August, September and October it drops gradually. Roughly from 50 to 75 per cent of the year's sales are made in four months. Such seasonal concentration is wasteful.

The situation is becoming constantly more unsatisfactory. As machines for construction call for more perfect mechanical design and structure, more exact workmanship and better field servicing after the sale, a permanent force of mechanics and field men becomes more necessary. Time is required to build up such a staff. The men cannot be laid off when factory work and shipments are slack. Virtually a peak-load force is required all the year, and for two-thirds of the time is larger than the work requires. Obviously here is an excess charge for production. A 10 per cent saving in cost could be attained if production were distributed evenly over the twelve months.

For the constructor, however, the chief gain will be not in the cost reduction but in certainty of delivery and prompt servicing. These cannot be assured when the manufacturer is straining his production capacity and when the railways are trying to sift in fast shipments of equipment with a peak movement of construction materials. Individual manufacturers are endeavoring to meet the situation by building up factory and distributor stocks, but the business does not permit of keeping a full stockroom. Requirements change too rapidly.

The task has to be attacked in a more fundamental manner. It is time that the equipment manufacturer stepped outside the factory and took his part in the march of engineers and contractors to bring about a twelve-month construction year. Working together with the materials producer, who suffers from the same seasonal demand for his products, he could bring a new force into a movement which has become hesitant.

What the Hoover committee on seasonal construction pointed out in its 1924 report—namely, that enormous economic wastes are involved in the traditional six-month construction season, has largely been forgotten. But it should be taken up anew in order to cure the evil of seasonal equipment production. Both manufacturers and materials producers now have associations for organized work which can in conjunction put new life into the effort to raise engineering construction out of the class of summer-resort hotel-keeping as a seasonal occupation. They should take hold of their task.

Notes of the Week

Construction Grows

MARKED increase in construction contracts during the second half of March gives tangible form to the forecasts for an active construction year which were deduced from budgeted construction as early as four months ago. In some fields, as road work, the seasonal revival is earlier than it was last year. A high rate of construction activity will be needed in order to carry through the contemplated amount of new construction, and it is to be expected that April and May will maintain the advance in contract lettings. A new factor is added to the construction outlook by the President's approval of the public buildings bill, which authorizes a considerable increase in rate of prosecution of the program for new post offices and other public buildings. It will tend not only to accelerate the current year's construction activity but also to add to the budgets for future years.

An Anniversary of Distinction

FIFTY years of useful service have been completed by the American Society of Mechanical Engineers. To commemorate the event a celebration is to be held this week. The ceremonies will extend over a period of five days, in three cities. Leading figures in governmental, educational and engineering circles will participate, and delegates will attend from the leading nations in every quarter of the globe. It is an impressive program, but a fitting one, for the mechanical engineer has been privileged to have intimate connection with the growth of our present industrial civilization. If the advance in technological knowledge during the half-century just ended has been amazing, there is every reason for looking forward to even greater progress. The pending event, therefore, presents an occasion for congratulations to both the society and the profession which it represents, not only for past accomplishments but also for prospects during the years to come.

Utility Regulation

NEW YORK'S state legislature is in the throes of attempting to develop a new system of regulating public utilities. An amazing number of bills, all intended to accomplish the same end by radically different means, are up for discussion in the few days which remain before the legislature adjourns on April 11. The bills are too numerous and too uncertain of passage to warrant discussion here, but they serve to emphasize the fact that dissatisfaction with our present method of utility regulation is becoming vociferous throughout the entire country. People have lost faith in public utility commissions, they are looked upon—and sometimes with justice—as aids of the power companies rather than of the people, in the problem of controlling utility rates. The courts, too, have made the case more difficult by complicating rate control through indefinite rulings. The result is the present reaction—an endeavor to simplify regulation by new legislation definitely fixing the rate basis by contract or other means. As in the case of reaction against excesses in the manipulation of railroads some years ago, the legislation which comes out of the present unrest may be repressive rather than equitable.

Heavy Penalties

FINANCIAL penalties for typhoid epidemics are becoming larger and more certain year by year. In addition to the heavy penalty of sickness and death caused by the water-borne typhoid outbreak at Olean, N. Y., in 1928 and the undesirable publicity that resulted from the epidemic, the city is paying hundreds of thousands of dollars to victims of the outbreak or their heirs. Apparently, the city has assumed complete financial responsibility for expense incurred and for loss of time and life, and is making settlements accordingly. This in itself is significant. It indicates that it is becoming hopeless for cities to contest damage claims made on behalf of typhoid victims. The lesson for Olean is all the harder because the outbreak there seems to have been due to official laxity, both in sanitary control of its water supply and in making prompt report to the state health department of the premonitory outbreak of diarrhea. Although such epidemics are becoming less and less frequent, there have been enough of them lately to serve as a warning to every city and company purveying water. Nothing short of constant alertness, exercised by keen, competent and quick-acting officials, will insure any community against a sudden typhoid outbreak—and such outbreaks today are sure to bring heavy penalties.

Checking Floods

"THERE will be no serious floods in the Hudson River Valley this spring." So reads a simple statement in a minor news item in the New York papers telling of the closing of the gates in the new reservoir which the Hudson River Regulating District has been building on the Sacandaga River, a major tributary of the upper Hudson. Measured by its importance to the cities of Troy and Albany, lying along the Hudson River, the statement should have been set out in blackface type on the front page. This spring there will be no major flood, because all the water of the Sacandaga River will be used to help fill the new reservoir at Conklingville, and other reservoirs are being drawn down to supply the deficiency in the present flow of the river caused by holding back the Sacandaga water. But next year and the next, and so on for an indefinite period, serious floods on the Hudson will be reduced if not entirely eliminated through the construction of this and other reservoirs proposed by the regulating district. Also, in the summer season more water will run down the river for the benefit of the community and the power companies. For this reason the cost of building the Conklingville reservoir is to be paid for chiefly by the power companies which benefit from the increased low flow of the river. The plan by which the Conklingville reservoir has been built is an ideal one. Flood control is combined as closely as possible with river regulation under an agency which builds and controls the reservoirs and distributes their costs upon the parties benefited.

Legal Hurdles Get Higher

AFTER having had a full share of legal difficulties, the East Bay Municipal Utility District, which has been delivering mountain water to the east side of San Francisco Bay for several months, seems to have cleared the last major obstacle. One by one the claims for real and imagined damages, totaling almost half the cost of the entire project, have been settled for a few per cent of the original demands. At the time the project was initiated the water situation was urgent, and immediate construction work was necessary, regardless of probable legal difficulties. Utilization of the Mokelumne River for this project involved a stream among the oldest of the state in point of use, and one of the most complicated in respect to land ownership, mining claims and water rights. Selection of the reservoir site and applications for water brought suits from land owners and water users. In the case of the latter, the court held in many instances that the plaintiff would be benefited rather than damaged by the effect of storage and regulation of the streamflow. Each year sees a greater demand for the utilization and conservation of the water resources, and at the same time intensifies the legal entanglements with which any scheme may be crippled. It is more and more evident that every engineer who sponsors a water-development scheme should study the legal phases involved before placing positive approval on the plan.

Aiding Building

THE first of several proposed amendments to New York City's building code became effective last week, and its immediate effect should benefit building. Projects which have been held up pending decision on this "steel and iron" amendment can now be begun with confidence. New projects to come will benefit from the economies of the 18,000-lb. unit stress and the reduced and more clearly defined live-load requirements in the new amendment. The economies from the stress increase alone will be appreciable, particularly where from 20,000 to 50,000 tons of steel is involved, as has been the case on some recent New York skyscrapers. The new amendment further recognizes the design problem of these tall buildings, by a wholly unique wind-pressure clause—20 lb. per square foot of exposed surface from the top down to a plane 100 ft. above the ground, all of the pressure to be taken by the frame. The amendment reflects much credit upon the competent committee of engineers and architects that drafted it. Also, it represents an important accomplishment for the present city administration, which is now committed to prompt consideration and adoption of the other amendments—on reinforced concrete, foundations, wood construction, masonry, etc. There is, too, the recommended provision to require engineers to file affidavits of code compliance with their designs and of construction compliance following competition. The reason given for not including this with the steel and iron amendment—namely, that it would hold up adoption of this amendment—was plainly a case of imagining ghosts. These affidavit provisions must be included some time. They have been received with universal acclaim. Public safety demands them. They should be a part of the next amendment adopted.

The Pipe-Line Hydraulic Dredge

A Highly Perfected Machine

By O. P. Erickson
Engineer, Great Lakes Dredge & Dock Co., Chicago, Ill.

It Is Difficult today to vision a channel deepening or a great operation of reclaiming land from the water without hydraulic dredges. With their long pipe lines they are familiar sights in all our harbors and rivers. The author of this article gives the birth year of the hydraulic dredge as 1855. In the 75 years of its life it has changed little in its elemental characteristics: A hull with supporting spuds, a pump and a prime mover, a cutter head and suction pipe and a discharge pipe were the elements of the early dredges and are still the dredge elements of the beautiful machines illustrated in this article. Every element, however, has changed. Hulls are of steel, and some of them are built in sections for easy transportation and assembly on the work. The power plants are steam-turbine, electric, diesel-electric and straight diesel. The pumps are of cast and alloy steel. The cutter heads are removable. The pipe lines have flexible steel couplings and welded seams. And the modern dredge has a recording instrument and control room comparable to that of an ocean passenger ship. This article visions all these facts and tells how the changes have come about and what the modern hydraulic pipe-line dredge is and what it can do. —Editor.

The first important step toward the hydraulic dredge was the invention of the centrifugal pump. Denis Papin in 1705 made the first centrifugal that actually pumped water. The first steam engine applied to a dredge was built by James Watt in 1795. Papin's embryo centrifugal pump had been improved by Andrews, Appold, Gwynne and others by the time it was first installed on a boat or barge and operated by a steam engine by Louis Schwartzcopff and Frederic Hoffman in 1855. They called the installation a hydraulic dredge. To them can also be credited the floating pontoon line, the pipes of which were connected with sleeves of leather or rubber hose. In 1856 they developed an oscillating pick or knife type of cutter, which is thought to be the original dredge cutter. This dredge worked successfully digging canals and filling in marshes near Berlin, Germany.

The earliest centrifugal-pump dredge built in the United States was the self-loading and self-propelling hopper dredge "General Moultrie," designed and built by Nathaniel H. Lebby and associates of Charleston, S. C., in 1855. This dredge was 150 ft. long and had hoppers built in the hull; its pump was 6 ft. in diameter and it used a 19-in. suction pipe. An agitator was fastened to the end of the pipe for stirring up the sand. The dredge was used successfully for dredging the Charleston bar after a ladder dredge had failed.

The earliest recorded forerunner of our present-day cutter was developed by one Atkinson of Vermont in 1862. This type of cutter was improved in 1869 by Duval of Baltimore and installed on his hydraulic dredge which was used for gold dredging in Central America. A more fully developed type was used in 1894 by Vivian on the Chicago Drainage Canal.

The application of the flexible ball joint to floating pontoon lines was another great forward step. Latest and most important have been the steam turbine, the electric motor and finally the diesel engine and the diesel-electric power units.

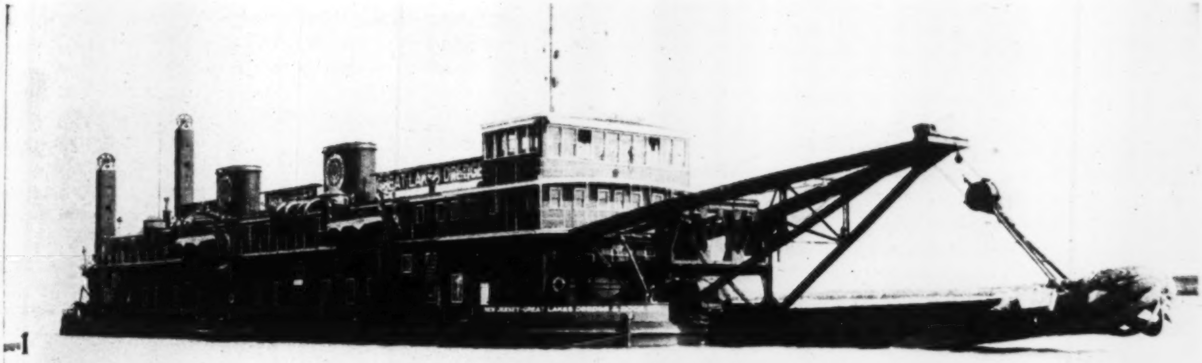
During the last few years great strides have been made in hydraulic dredges and their equipment. Among these improvements are dredge hulls with sharp or rounded ends, instead of the square ends used heretofore. Dredges with sharp or rounded ends are easier to tow and offer less resistance to the current when working in swift-flowing tidewater. Steel hulls are taking the place of wooden hulls, particularly for the larger sizes of dredges. These hulls have watertight bulkheads, which mean lower insurance rates, as they are a reasonable assurance against sinking from collision with passing craft when operating, or from foundering when caught in a storm at sea during tow from one job to another. The bulkheads also stiffen and strengthen the hull. Substantial longitudinal trusses are used with few exceptions on dredges above the 24-in. size.

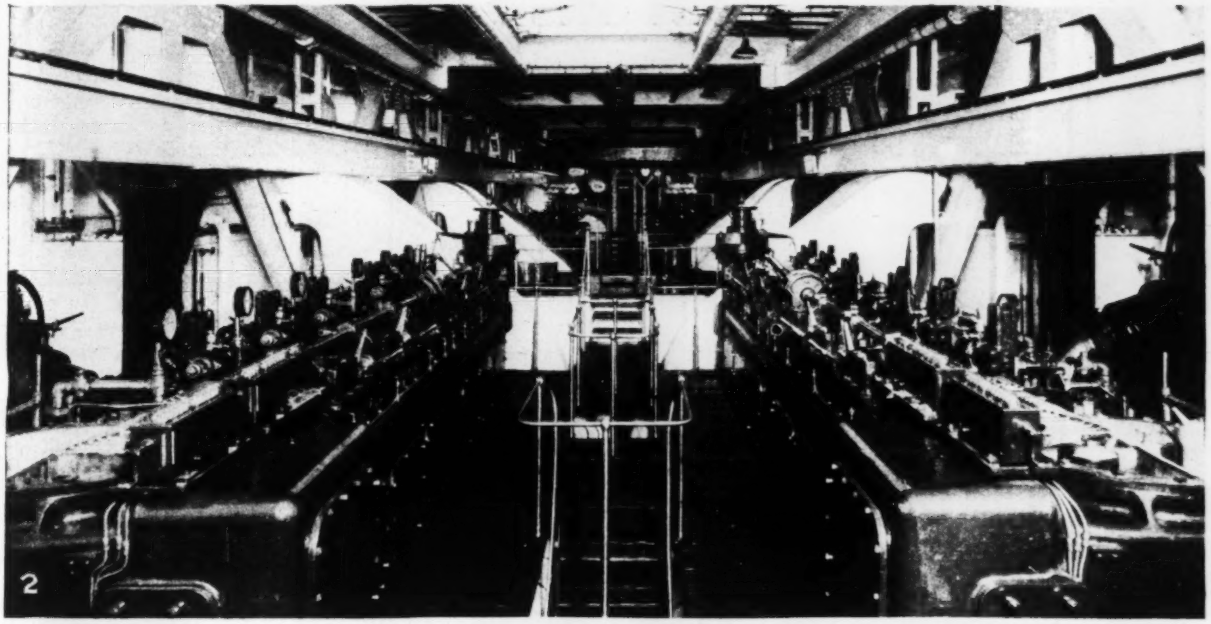
The size and capacity of hydraulic dredges depend on the work to be done and on the contractors. Ordinarily smaller contractors have dredges from 16 to 24 in., while the larger companies have from 15- to 30-in. dredges. The horsepower used on the main pump and cutter on these dredges varies greatly according to the individual contractor's viewpoint. An average value of the shaft horsepower of dredges lately built or converted to turbine drive seems to be: for the 16-in. dredge, 600; 18-in., 900; 20-in., 1,200; 22-in., 1,600; 24-in., 2,000; 27-in., 2,500, and 30-in., 3,000. The cutter power is about 20 per cent and the swing power about 4 per cent of the pump shaft horsepower.

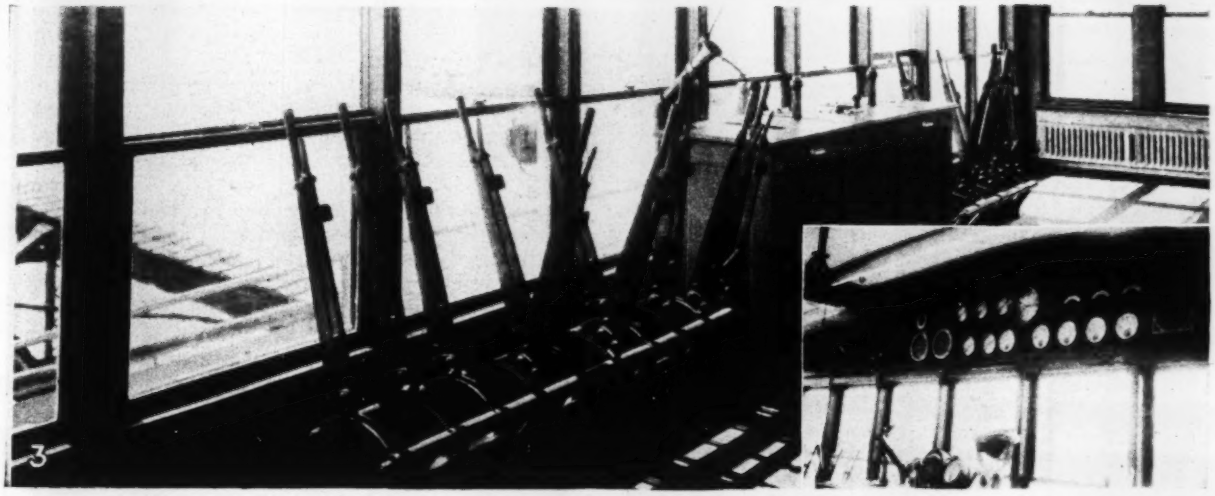
Diesel and Diesel-Electric Power Popular

The present-day dredge power plant tends toward dieselization. Most of the new dredges built, both large and small, are diesel-electric, geared-diesel or straight-diesel drive. The world's most powerful dredges, the "New Jersey," of the Great Lakes Dredge & Dock Co.; the "Clackamas," of the port of Portland; the "Las Crusas," of the U. S. government in the Canal Zone, and the "Norfolk," of the Atlantic, Gulf & Pacific Co., are all diesel-electric. There are several diesel dredges driving the pump through speed-increasing gears such as the "New York" and the "Diesel," of the Standard Dredging Co. There are also direct drives as on the "C. B. Harris," of the U. S. Engineer Corps, and the dredges of the Hill Co., Atlantic City, N. J.

Diesel-electric dredges have shown an exceptionally steady operating performance, breakdowns of the en-







THE LATEST DEVELOPMENT IN HYDRAULIC PIPE-LINE DREDGE CONSTRUCTION

(1) Diesel-electric dredge, 5,000-hp. 30-in. (2) Looking forward in 5,000-hp. engine room. (3) Operating room of 5,000-hp. dredge. (4) Gage board, including gyro-compass.

gines and electrical equipment being almost negligible. They have more flexibility than any other type of hydraulic dredge on account of the easy regulation of the cutter and main pump speed and the ease with which power can be used where most required. An important feature of multi-engined diesel-electric dredges is that when necessary they can usually be operated at a reduced output with one engine shut down. With dredges using the straight drive, and particularly with the speed-increasing gear drive to the main pump, trouble has been experienced with critical speeds. Therefore the design should be gone over thoroughly by a competent authority, and if the calculations indicate critical speeds within the operating range, the necessary changes should be made in the design to eliminate these to an absolutely safe factor.

The foundations for diesel engines are built stronger than for steam reciprocating engines or steam-turbine drives and receive close attention when designing a diesel dredge. Several types of engines are used by the different contractors.

Electric dredges using all industrial power have been found very cheap to operate and of low first cost. The cheapness of operation depends, however, to a large degree on the cost of power and the length of the transmission line required. The distance the power has to be transmitted over land and water to the dredge makes this type of dredge unsuitable for a number of jobs.

Steam Turbines Supplant Reciprocating Engines

Geared steam turbines have been used for a considerable period by the Standard Dredging Co., both for the main pump and for the cutter; they are also used by the port of Portland. Recently the Standard Dredging Co., the Great Lakes Dredge & Dock Co. and the Atlantic, Gulf & Pacific Co. have converted several of their steam reciprocating engine dredges to steam-turbine drive. With the steam-turbine drive more shaft horsepower can be obtained per pound of steam. The turbine has a higher overload capacity than the reciprocating engine, costs less to operate, can use a smaller dredge pump and is less likely to break down. Superheaters are installed with steam turbines whenever possible. On most turbine-conversion jobs, however, the steam pressure carried by the old boilers is too low for efficient steam-turbine operation and cannot be raised, but where new boilers are also installed higher steam pressures are used and with them added economy is obtained.

Boilers for steam dredges are with few exceptions water-tube boilers. These are preferred because of their rapid steaming qualities and general ease of operation and flexibility. They are also fairly safe from dangerous explosions due to low water and other causes. It is considered good practice for dredges above 20 in. to have sufficient boiler power so that one boiler can be cut off the line and cleaned without stopping the dredge. All boilers should have an efficient soot blower system. Oil fuel, when it is available, is used almost exclusively; it is clean, the boiler can be forced more than with coal and fewer firemen are required.

Suction Pipe, Ladder and Cutter Design

The suction pipe on the well-designed dredge is usually 3 to 4 in. larger than the discharge pipe; otherwise when operating on short pipe lines the digging vacuum would be insufficient to insure the maximum output of the dredge. Cast steel is used when necessary for elbows and offset sections. For the straight sections on suction and discharge pipe, electric-welded and sometimes hammer-welded pipe of 30-40 carbon is used. There seems to be little choice between the swivel elbow and the ball joint in the suction pipe, although the ball joint appears to have a better streamline passage for the water than the elbow. However, for the flexible connection at the stern of the dredge, there is a decided preference for the swivel elbow, as it admits of much greater swing than the ball joint. But for working in rough and exposed water the ball joint stands up better than the swivel elbow.

The ladder is one of the most important parts of the dredge and special care is taken to design it to stand up under the hardest digging likely to be encountered. For the smaller dredges up to 24 in., girder beams are sometimes used for the sides, and with strong diaphragms and bracing make a strong ladder for the weight. For the larger dredges the sides and the diaphragms are of structural steel throughout. The suction head and trunnions are steel castings and the trunnions are made large and provided with good lubrication. Particular care is taken to design the outer end of the ladder properly for digging in shallow water without dragging and to be able to get down to grade quickly. Chafing plates with provision for taking up the wear are used on all well-designed dredges. The swing sheaves, with few exceptions, are placed on the ladder of the dredge as close to the cutter as practicable. This eliminates the heavy stresses set up in the ladder when using sheaves from the bow of the dredge. There is also more power available for pulling the dredge into the bank when ladder sheaves are used.

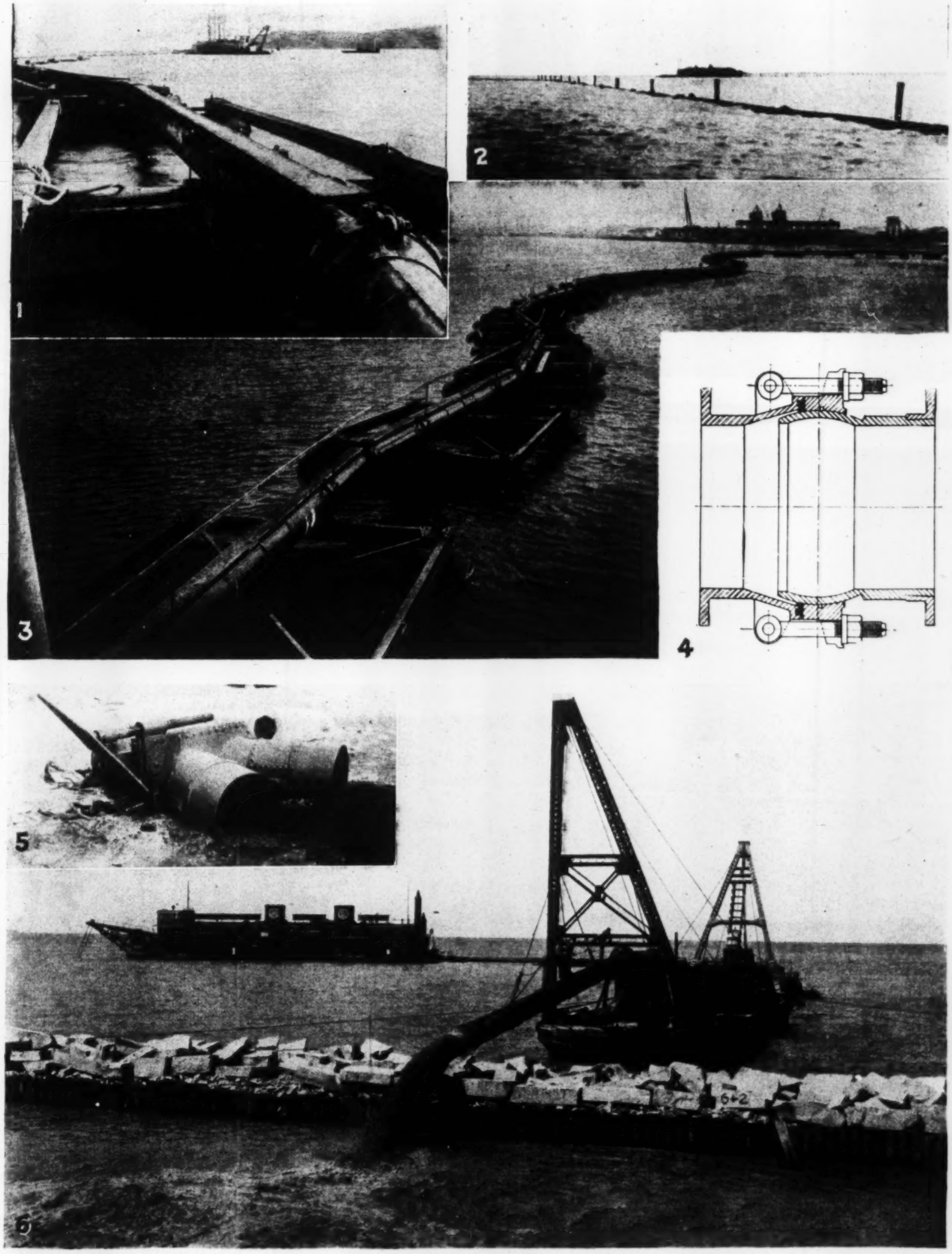
The type of cutters most used today is the Plummer—the cutters used by the Great Lakes Dredge & Dock Co. and by the Atlantic, Gulf & Pacific Co. They will dig any type of material without clogging and are strongly designed. This cutter is screwed onto the shaft against a 45 deg. shoulder, using a double or triple acme thread. This arrangement makes it easy to change cutters. All danger of the cutter working loose on the shaft is also eliminated. Rubber cutless bearings have now come into use for the cutter-head bearing and have given complete satisfaction. Both the shafts and the bearings seem to wear but little compared with the old style cast-iron or babbitted bearings.

The electric motor is coming to the front for cutter drive, because of its advantage over the steam turbine and reciprocating engine in flexibility of speed and power. It is better adapted for installation on the dredge ladder than either of the other drives. With the cutter motive power on the ladder, the objectionable features of driving the cutter through ladder trunnions or through telescoping shafts and flexible couplings, from deck to dredge, are eliminated.

The swing motors on all the later high-powered dredges are reversible. This feature saves time and trouble from fouling lines on the niggerheads and the labor of overhauling the swing cable drums.

Dredge Pump Design

The main pump is located somewhere near the front end of the dredge in order to shorten the suction pipe as much as possible. The best practice appears to have the bottom of the suction pipe near the pump at or a few inches above the normal draft line of the dredge. This allows the drainage of the pump down to the bottom of the pipe. The installation of jets in the suction head assists in pumping some types of material and will also quickly prime the pump when required. Almost



PIPE-LINE ACCESSORIES FOR MODERN HYDRAULIC DREDGE PLANT
(1) Ball joint and pontoon connections. (2) Submersible pipe line before sinking. (3) Modern pontoon line. (4) Details of ball joint. (5) Shore line valve for small dredges. (6) Pipe-line barge for floating discharge.

all dredge pumps are of the circular-case type with square or circular volute. The efficiency of the two types is about the same, but the square-volute type is preferred, as it is easily lined. The efficiency of the circular-case pump is somewhat greater and it is also easier to keep lined than the spiral-case type.

All pumps for high-powered dredges are now made of cast-steel and some are made of alloy steel for additional strength and wear. The liners used, no matter what shape, are usually plate steel, cast-steel or cast-iron, and sometimes alloy steel. There is little choice between the first three in the wear obtained, but alloy steel wears considerably better. Rubber liners also seem to hold promise, at least when sand is pumped. The design of the pump impeller is very important, particularly the proper curvature of the vanes. On some of the later dredges an opening is provided in the top of the pump casing through which a bar can be introduced to knock loose rocks or boulders which may get stuck between the impeller vanes.

The Kingsbury thrust bearing is now being installed on nearly all new dredges and has replaced horseshoe thrust bearings on a number of old dredges. Roller and ball bearings are also used on a smaller scale.

A slipping clutch installed between the engine or motor and pump and adjusted so it will not slip until the impeller jams in the pump from some cause or other is an important safety measure used on some of the later high-powered dredges.

Steel Spuds Supplant Wood

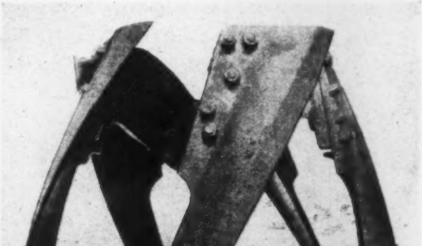
Steel spuds are now used with few exceptions on all high-powered dredges. The spuds can be made to any diameter and length required by electric welding or riveting or both, or by hammer-welding. By whatever method they are made, the spuds are usually reinforced on the inside by I-beams, channels, angles or diaphragms, or a combination of these. For smaller dredges, spuds are sometimes made from H-beams with oak filling between flanges to the proper size for the spud wells. Square spuds with the point turning on the spud are used and have been found very satisfactory. Almost all new dredges have hinged spud gates so the spuds can be easily shipped and unshipped. This arrangement also requires a shorter spud gantry. With few exceptions dredges over 24 in. have the spud machinery aft and separate from the swing machinery.

Discharge Pipe Line Practice

The most recent practice is to lay the hull discharge pipe either on the deck outside the deckhouse or in a trough on the deck designed for the pipe. Both these arrangements make for ease of replacement and obviate the danger of sinking the dredge from a split discharge pipe. Pontoon pipe is at present made almost wholly by electric welding of 30-40 carbon plate, although some is made by hammer-welding. The hammer-welded pipe costs a little more but is somewhat stronger than the average electric-welded pipe. The lengths used to a great extent on the Atlantic and Pacific coasts are 45 to 48 ft. These lengths permit shipment by rail using 50-ft. cars. On the Great Lakes and in some other localities 100-ft. lengths are preferred, as they are less affected by wave action. The thickness of the pipe wall varies from $\frac{5}{16}$ to $\frac{7}{8}$ in.

Ball joints with few exceptions are used on all high-powered dredges, as their economy over the rubber sleeve is unquestionable. The best known and most used by a number of prominent contractors as well as by the government is the Plummer joint in all sizes up to 30 in. Whatever type is used, the best practice is to bolt the male and female sections to the pipe with flanges. This makes removal easy and two or more sections can be bolted together without the ball joint under favorable conditions. One bad feature of all present-day ball joints is the time required to disconnect and connect the joint when installing pontoons.

The pontoon float favored by the average contractor is the can float with dished heads. The sizes of the cans vary with the pontoon pipe sizes, although the same cans usually may be used for the 20- to 24-in. pipe. The cans are sometimes made of copper-bearing steel as a protection from rust. All cans now made are electric welded.



MODERN REMOVABLE CUTTER FOR HYDRAULIC DREDGE

The advantage of this type of pontoon line is that it can be quickly assembled and taken apart and shipped by car or boat at low cost. There are, however, conditions where a special type of pontoon line is superior to the can type, as for example on the Great Lakes, where considerable dredging is done in the open lakes. The pontoon line used by the 5,000-hp. diesel-electric dredge "New Jersey" has permitted this dredge to operate under weather conditions when the can-type pontoon line would have broken up in short order.

The shore pipe most used is electric-welded, 30-40 carbon steel pipe and the standard length for dredges between 20 and 30 in. is between 15 and 16 ft. The thickness varies usually between $\frac{5}{16}$ in. for the larger to $\frac{5}{32}$ in. for the smaller dredges. The present-type shore-line valves require considerable improvement. With few exceptions they cannot be opened or closed except under the lower heads, which means that under high heads the dredge has to be stopped while the flow is changed from one line to another. On shallow fill jobs where a number of pipe lines are used this causes great delay.

The handling of shore pipe lines is being done more and more by light dragline excavators. These machines when not handling pipe are usually busy casting up levees or leveling off high spots on the fill. A plugged pipe line that would take days to break up in the old way can be broken up in a short time by a dragline.

Telephones are now used even on short pipe lines. The single-wire magneto type phone has been used for years and has proved very satisfactory. The phone is usually connected to all the control points on the shore line and to the operating room on the dredge.

Recently pipe lines of 5,000 ft. or more have been successfully submerged on the bottom of lake or harbor. The ends of the line are blank flanged, towed to the site and connected to the pontoon line at one end and to the shore line at other end. A substantial anchorage is installed at the pontoon line end for anchoring the pontoon line. Whenever it is required to move the line to a new location it is blown out by air pressure, floats to the surface and is towed to the new position and sunk again. This proves a quick means of laying a pipe line when otherwise a long and costly trestle would be required. Ball joints are always used in preference to rubber connections, in order to avoid the danger of leaky or burst sleeves burying the pipe line before the lead is discovered.

On long pipe lines and contracts of any magnitude, where it is evident that the discharge velocity will be too low to carry the solids at an efficient speed, it is good practice to use a booster pump. The booster may be another hydraulic dredge connected in series with the main dredge, or a diesel engine or electric motor installed on a barge with the required auxiliaries. The suction side of the booster pump usually shows from 5 to 6 lb. pressure for best operation. This means that the location of the booster in the line must be carefully selected. A bypass should be installed, so that if the booster pump or motive power breaks down, the dredge can operate at reduced output without the booster. A complete phone system is installed for communication between the booster pump and the dredge.

Gyro-Compass Guides Operation

The gyro-compass is of great value to the contractor, as it eliminates to a certain extent digging ranges now required for each cut. It is invaluable in exposed locations where it is difficult or impossible to maintain range piles. The operator can also maintain a straighter cut and attend to the digging operation more closely, as he is not required to peer for his range marks or lights, particularly on a foggy day or night. The course recorder incorporated in the gyro-compass gives a most complete record of all delays, time required for each swing and the width of the swing. It is a complete analysis of the operator's performance during his shift.

Dredge Performance

The performance or output of hydraulic dredges varies greatly with the material pumped. As, for instance, one 30-in. suction and 26-in. discharge dredge, powered with about 1,600 s.hp. on the pump, on 1,800 ft. of pipe line and 9 ft. elevation, pumped in 23 continuous operating hours 53,000 cu.yd. of sand and mud. The same dredge with 1,250 ft. of pipe line and an elevation of 8½ ft. and developing the same horsepower pumped 9,500 cu.yd. of hard clay mixed with large clamshells in 22½ continuous operating hours. Likewise the length of pipe line through which a dredge can pump will vary with the material—for instance, a 30-in. dredge with 3,000 hp. can pump gravel through about 5,000 ft. of pipe line with an elevation of 6 to 8 ft., and the same dredge can pump a sand and mud mixture through a pipe line around 15,000 ft. long with the same elevation.

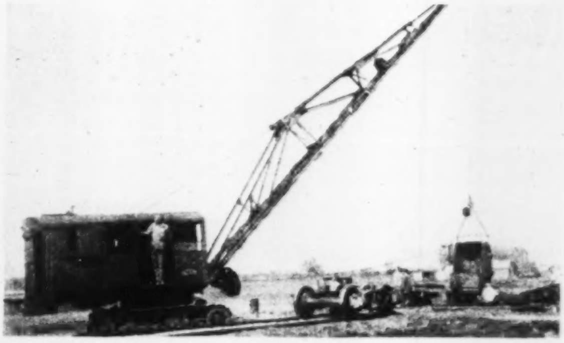
The materials that can be handled by a well-constructed hydraulic dredge range from mud and silt to some of the softer grades of rock. In rock digging, however, a special cutter with inserted teeth is usually found preferable to the plain blade cutter that is standard for other materials.

Handy Method for Unloading Shovel or Dragline

Removing Front Trucks From an Extra Flat Car, the Latter Becomes a Sturdy Ramp

By Darnall Burks
Junior Highway Engineer, U. S. Bureau of Public Roads

The customary method of unloading a heavy piece of equipment calls for a runway of heavy timber cribbing. The time and expense involved in securing, hauling, placing and returning these timbers are frequently a considerable item. By a method used recently on a Texas bridge job only two or three ordinary railroad crossties are needed to bridge the slight drop from the car floor to the ground.



DRAGLINE LIFTING END OF FLAT CAR

In this case the dragline, which was equipped with a 50-ft. boom, arrived at the siding on two flat cars. The first step in the unloading was to mount the boom and get the machine into shape for operation. With the dragline resting near the middle of one car, a chain was passed under the front end of the other car just ahead of the front truck and attached to the bucket tackle. Power was then applied to lift the body of the car clear of the truck.

The process of removing the truck is very simple. Only one connection must be broken. This involves merely the removal of the pin which connects the brake lever on the truck to the piston rod of the main brake, which is attached to the car frame. The car frame rests on the truck by means of a countersunk seat, with no other connection. As soon as the brake pin had been removed the car frame was lifted clear of the truck, which was rolled away. Slacking away on the tackle then lowered the car frame to the rails. Three crossties were placed on the rails at the lowered end of the car floor in order to make the jump to the ground less abrupt, and an ideal runway was completed down which the dragline, entirely under its own power, then proceeded to the road along the siding. Here it swung around and again picked up the end of the car and held it until the truck was rolled back in place and the brake pin replaced, when the car frame was lowered and the job finished. The reverse process of loading should be equally simple.

The illustration shows the slope of the runway and the dragline ready to pick up the lowered end of the car. The total time required for the unloading, aside from mounting the boom, was 30 minutes and the only men required were the dragline operator and his assistant.

Development of the Dragline Excavator

A Universal Earth-Moving Tool

By J. C. French
Sales Manager, Monighan Manufacturing Corporation, Chicago, Ill.

In a Little Over a Decade engineers have seen the dragline excavator become a serious competitor of the power shovel, not only in operations requiring a long reach of boom but for loading wagons and cars and excavating operations generally, where formerly the older excavator ruled supreme. In this article the builder of some of the largest dragline excavators in the world, by pictures and text, tells what the successive improvements have been, what the structural and operating features are that commend the dragline as an excavating machine and how it is applied in various operations of mine stripping, canal excavation, levee building and general earth moving. An added interest is given to this review by the great work of levee building on the Mississippi, in which the dragline is being used in all sizes from the small machine handling buckets holding a fraction of a yard to the 350-ton giants with 6-yd. buckets and a working swing of nearly 400 ft. from pit to fill. It is a marvelous machine development that is so tersely related in this article. And as has so often been the case in equipment advance, the impetus came from a single invention—the notably simple dragline sling for scraper buckets. —Editor.

The dragline excavator was definitely established as an excavating unit during the building of the Chicago Drainage Canal about 1896. The first machines consisted of a revolving wooden derrick frame and boom, mounted upon skids and rollers. This device met with favor, and adaptations of locomotive cranes, derrick cars and any boom device to drag bucket operation figured as the forerunners of the modern dragline. Efficient operation, however, was not obtained, owing to the complications of bucket design.

The first successful dragline bucket was used on the Hennepin Canal in 1903. This bucket, developed from Chicago Drainage Canal practice, was so extremely simple in control and operation that the working practicability of the dragline principle was immediately established. From this date dragline improvement has been devoted principally to the machine proper to bring it to an efficiency corresponding with the simplicity of the bucket principle.

The excavation of the New York State Barge Canal in 1908 again demonstrated the versatility of the dragline excavator for all classes of excavation. The Calumet-Sag Canal excavation in 1912 brought about the application of electric power and recorded another step in dragline development. About this time gasoline and kerosene engine power plants were applied to draglines, especially the smaller units, and demonstrated that the internal combustion engine was suitable for dragline service and was ideal for isolated operations.

In 1909 the first crawler-traction mounting appeared. The earlier models consisted of wooden slats or pads with plate armor on top and bottom. This construction was soon changed to the present all-metal construction.

In 1914 the small caterpillar dragline appeared, but did not meet with great favor. Contractors at that time did not recognize the value of these small machines, and not until 1916-18 did they meet their first real demand.

A new traction unit appeared in 1914, known as the walking device. This consisted of a combination of an operating base, a pair of walking shoes or pontoons and a pair of cam segments. The cam segments automatically raised the base from the ground, and by means of the rolling action of the cam segments the main body of the machine moved or stepped ahead a predetermined distance.

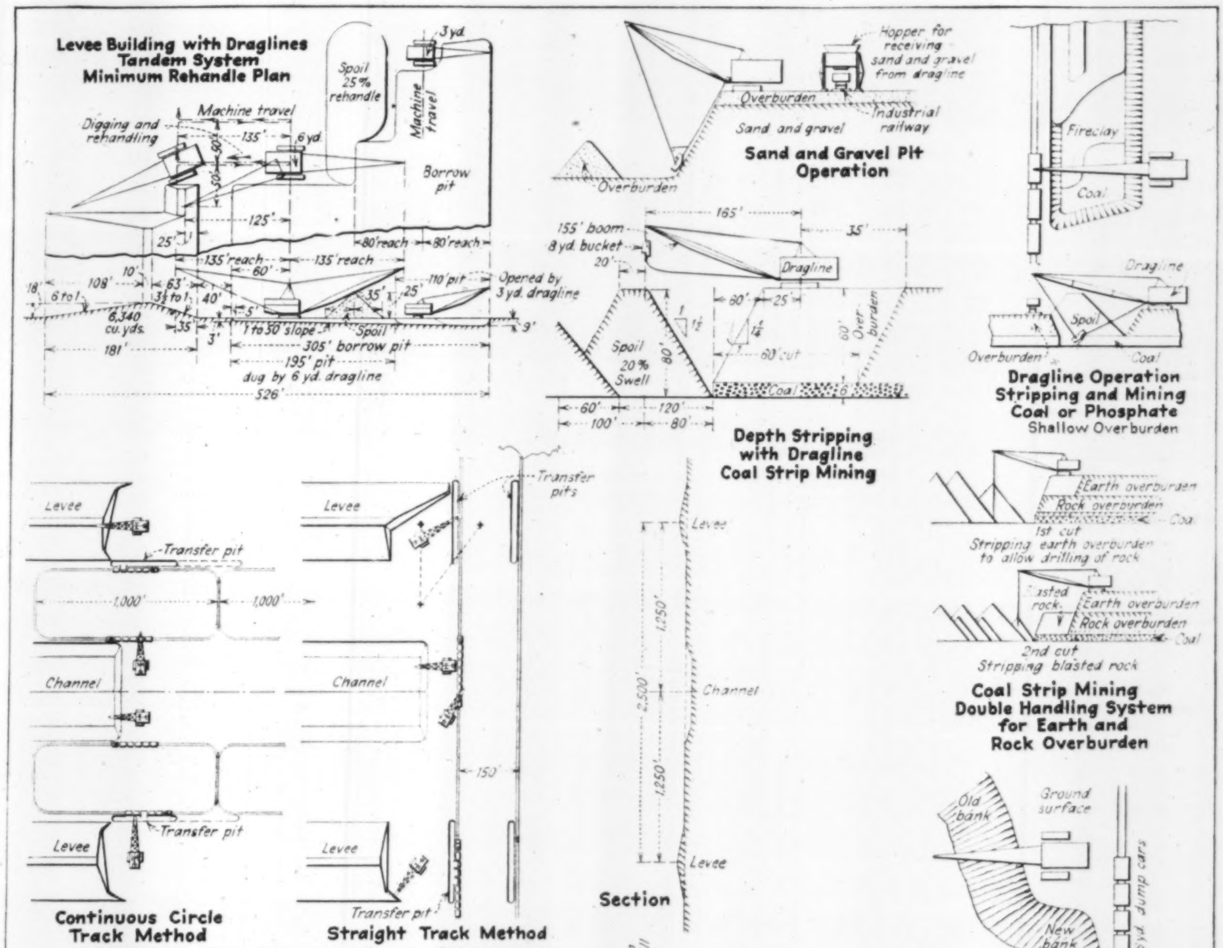
The earlier machines were mostly operated by steam or gasoline, but in 1918 the diesel engine was introduced. The first installation consisted of a four-cycle, air-injection type engine and the field tests were not entirely satisfactory. However, a definite idea was established as to power application, and the shortcomings of the first engine were soon overcome. About 1921 the semi-diesel two-cycle engine was used, and the field results encouraged the introduction of the full-diesel two-cycle type in 1924.

All of the earlier dragline excavator models were based upon the revolving derrick, with steam hoisting engines and drum units. These hoisting engine outfits failed to meet the real requirements of the new service, because of inherent weaknesses and lack of adaptation to the work. Manufacturers met the new demand by placing upon the market machines designed and built especially for dragline work. Exclusive dragline excavator manufacture began about 1905.

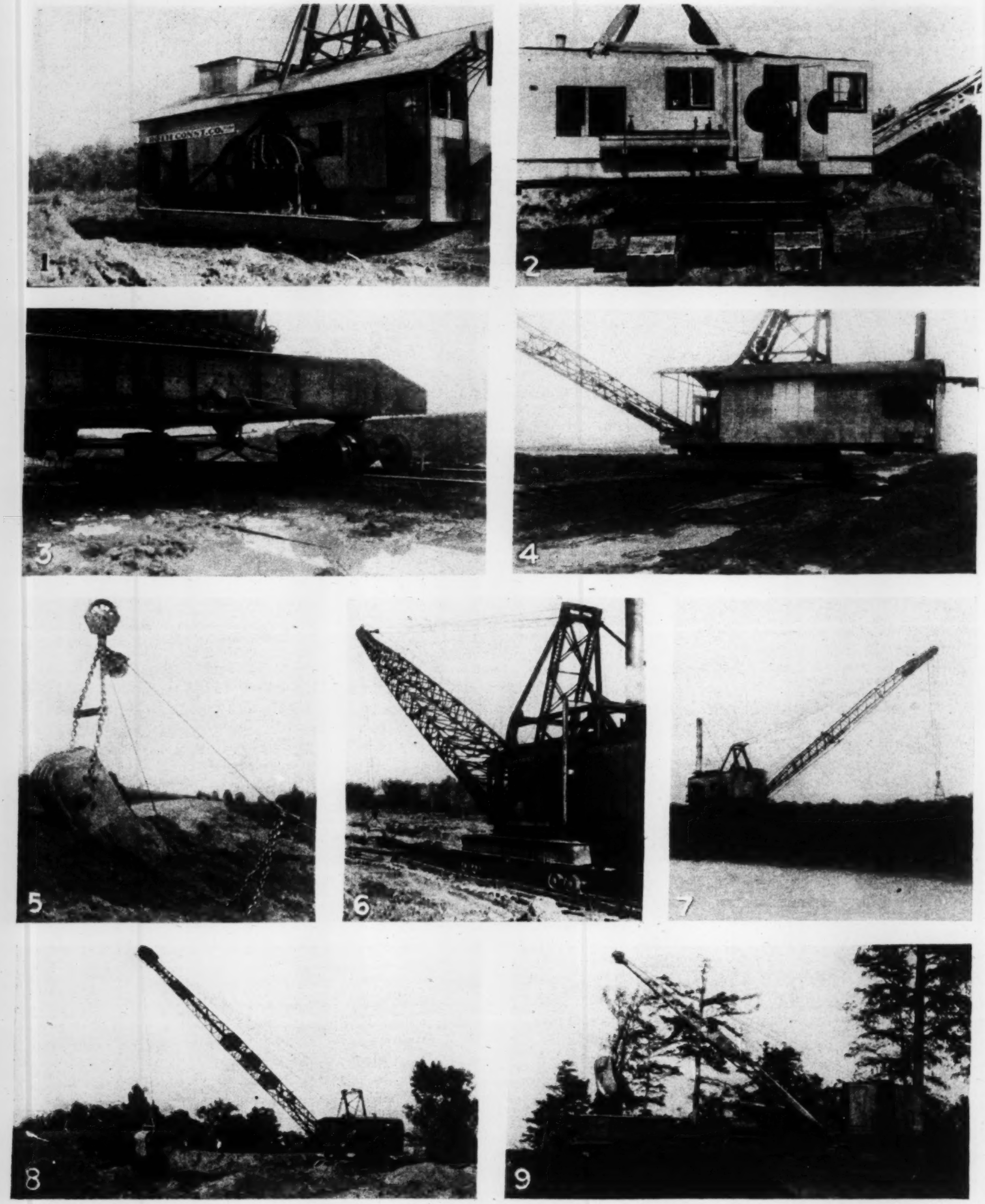
In the early days each builder brought out a special design in accordance with his ideas of construction and application. They all involved the same general principles of operation and differed mainly in the detail of construction and arrangement of the operating cables. Today dragline design is more or less standardized and varies only in the traction equipment and power plant, and the machines are manufactured as a regular line.

Argument for the Dragline Principle

The dragline method of excavation has gained its wide adoption because it reduces the amount of labor and equipment necessary for a given piece of work by combining the three phases of operation—digging, elevating and conveying—in one machine controlled by one operator. The dragline handles a large bucket for a given power unit. Little if any lifting force is required while the bucket is filling, and the power for loading is applied in nearly a straight line from the winding drum set. This makes it possible to exert practically the entire power of the engine in filling the bucket and in cutting through obstructions. The excavating bucket is under complete control of the operator, and this allows him to control


Levee Building with Draglines Tandem System Minimum Rehandle Plan
Digging and rehandling
Machine travel
135'
6 yd.
3 yd.
Spoil 25% rehandle
Machine travel
Borrow pit
125'
25'
80' reach
80' reach
135' reach
135' reach
60'
10'
108'
63'
18
6 to 1
3 1/2 to 1
40'
6,340 cu. yds.
35
3'
1 to 30 slope
Spoil
110' pit
Opened by 3 yd. dragline
9'
305' borrow pit
195' pit dug by 6 yd. dragline
181'
526'
Hopper for receiving sand and gravel from dragline
Overburden
Industrial railway
Sand and gravel
Sand and Gravel Pit Operation
Overburden
165'
155' boom
8 yd. bucket
35'
20'
Dragline
60'
25'
Spoil 20% Swell
80'
60' cut
60' Overburden
Coal
60'
120'
100'
80'
Depth Stripping with Dragline Coal Strip Mining
Fireclay
Coal
Dragline
Spoil
Overburden
Coal
Dragline Operation Stripping and Mining Coal or Phosphate
Shallow Overburden
Earth overburden
Rock overburden
Coal
1st cut
Stripping earth overburden to allow drilling of rock
Blasted rock
Earth overburden
Rock overburden
Coal
2nd cut
Stripping blasted rock
Coal Strip Mining Double Handling System for Earth and Rock Overburden
Levee
Transfer pit
1,000'
1,000'
Channel
Transfer pit
Levee
Continuous Circle Track Method
Levee
Transfer pits
Channel
150'
Levee
Transfer pit
Straight Track Method
COMBINED CHANNEL AND LEVEE OPERATION
Levee
1,250'
2,500'
Channel
1,250'
Levee
Section
Old bank
Ground surface
6 yd. dump cars
New bank
Locomotive
Industrial railway
Overburden
Clay bank
Clay
Dragline Excavator Operating Clay Pit
Work symmetrical about this c.l.
Digging position first cut
Digging position second cut
C.L. base and center of rotation first cut and fill
C.L. base and center of rotation second cut and fill
Step 42'
110' boom
Dumping position first fill
Dumping position second fill
Application of Dragline Excavator to Proposed Cut and Fill
Datum
18'
First cut
Second cut
First fill
Second fill
30'
110' reach
75'
75'
150'
75'
30'
30'
52'
30'
367'
Old spoil
Fire clay
Coal
Spoil
153'
153'
4,320 sq. ft.
3,600 sq. ft.
30'
82'
60' Overburden
60'
60'
5' Coal
One Operation Stripping and Coal Loading with Long Boom Dragline
Net sectional area - 550 sq. ft.
Plus 20% for shrinkage 110 " "
Total sectional area 660 sq. ft.
Two-Cut Ditching Operation
C.L. base of machine for first cut
C.L. base of machine for second cut
70' boom
30° inclination
Sectional area - 550 sq. ft.
65'
7'-6"
20'
First cut spoil
First cut
10'
Second cut
7'-6"
65'
Net sectional area 550 sq. ft.
Plus 20% for shrinkage 110 " "
Total sectional area 660 sq. ft.
Second cut-spoil
20'
53'
25'
10'
100'
10'
25'
53'

TYPICAL APPLICATIONS OF DRAGLINE EXCAVATORS IN EARTH MOVING



DRAGLINE TYPES AND TRACTIONS EMPLOYED ON MISSISSIPPI LEVEE CONSTRUCTION
(1) Walking traction. (2) Crawler traction. (3) Truck traction. (4) Roller and skid traction. (5) Dragline bucket and sling. (6 and 7) Types of booms and mast frames. (8 and 9) Types of small draglines for loading wagons and cars.

the shape of his excavation and the placement of the material.

The dragline pulls the bucket toward itself in digging and loading, and hoists and swings the load from the point of digging to the point of discharge. The boom is light and long, as it is subject only to the weight of the excavating bucket and its load, plus the side strains of swinging. This light boom allows a fast pickup of the load and a fast swing, as the resistance is extremely low. The connection between the digging bucket and the machine proper is entirely by cable, and as cable is flexible, shocks and unusual strains are eased before reacting upon the point of application of power.

The digging stresses of a dragline machine are transferred to the drum set through a fair lead or sheave set, located on the machine frame at the foot of the boom. This fair lead feeds the cable to the drums in even layers so that cable life is prolonged. There is no overturning effect in digging and the power is applied without the usual loss that exists where the power lines are operated over a number of sheaves. The reach of the dragline excavator is not limited to the length of the boom, but can be increased by swinging the bucket out beyond the boom end and there dropping it into a digging position. The increased reach is approximately 25 per cent greater than the boom reach. This long reach makes possible a large yardage at one setting.

Operating Economics Depends on Traction Device

Unless easy travel is obtainable regardless of the conditions of the ground or the surface, the dragline is severely handicapped in operation and results. Movement of the machine is a definite requirement; unless the machine is enabled by the traction device used to assume the most advantageous digging positions to meet the excavation problem presented, proper yardages cannot be maintained.

The machine weight must be distributed properly upon the ground surface so that matting and timbering are not necessary, and the maneuvering ability must be unlimited in direction. Ability to sidestep and zigzag in traction movement will allow the machine to add to its boom reach, enabling it to open a wider cut than would ordinarily be practicable under restricted scope of action. Spoilbank, embankment and levee problems also require the machine to step back out of line for short distances to obtain extra yardage or section corrections, and this requires a flexible traction unit.

Some of the devices used for dragline traction are efficient in operation; others handicap operation under certain conditions, and careful consideration must be given to a choice. The various types are described as follows:

Skids and Rollers—This mounting consists of a series of rollers and skids with the path made of planking. The movement is obtained by pulling the machine ahead on the rollers by means of the dragline bucket, which is used as a deadman. The skids are made of wood and rest directly below the structural members of the lower framing of the machine. Movement is generally a slow process and adds man power. The timbering and matting are items of continuous expense and the rollers must be watched carefully to eliminate the danger of accidents. Maneuvering the machine is slow and difficult and present-day operation indicates the passing of this method of heavy machine transportation.

Truck Mounting—This mounting generally consists of a four-wheel truck mounted on each corner of the lower base framing of the machine. These trucks run on rails, and the rails in turn are supported by timbering and mats in order to distribute the weight over a large area to prevent ground difficulties. Some of these trucks are designed for three-point suspension, while others are designed with hydraulic jacks. Most of the truck types are driven from the power plant, but a few are arranged to be pulled along by using the dragline bucket as a deadman.

Crawlers—Crawler tractions consist generally of two or four moving platforms which are designed to allow the machine to move ahead under its own power. Some of the larger types have eight caterpillar sections arranged in pairs at each of the four corners of the lower framing of the machine. The smaller types are arranged to operate on ground capable of withstanding a pressure of 10 lb. per square inch, but the larger types require matting and timbering, as the bearing pressures run to high figures. The crawler mountings on the smaller machines allow the maneuvering ability necessary for sidestepping, zigzaging, etc., but the larger machines are not capable of giving these results.

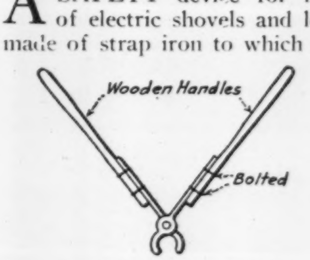
Walking Device—The walking traction consists of a circular base that rests directly upon the ground when the machine is in operation for digging, and of two pontoons upon which the machine rests when it is walking. A mechanical arrangement is provided which transfers the weight of the machine from the operating base to the pontoons and which automatically produces a stepping action in any direction that may be desired. This direction control is obtained by swinging the upper revolving frame, which supports the pontoons, into the direction in which travel is required, and movement is then obtained by contacting the walking device control.

This walking device is designed to operate without the need of matting or timbering upon any class of ground that will bear a load of 7 lb. per square inch. This figure is maintained with all sizes of the machines. Sidestepping, zigzagging and complete reversals are obtainable.

The dragline excavator in its various sizes and mountings will handle earth and blasted rock in both excavation and fill; it is a general excavator. It will excavate to great depths below the frame and will deposit at great heights above. It will excavate under water as well as from dry pits. The applications are so many and the procedures so various that description and discussion belong to a manual of construction. In this presentation they are indicated only by the drawings and diagrams of the full-page illustrations.

Tongs for Electric Cables

A SAFETY device for handling the power cables of electric shovels and loaders consists of a pincer made of strap iron to which are bolted wooden handles about 18 in. long. These cables often have to be handled in wet and dangerous places, while their insulating covering is likely to be worn or abraded by hard usage. The tongs can be made at any shop, the jaws being made of suitable size to grip the cable. This device is described in the *Mining and Metallurgy Bulletin* of the American Institute of Mining and Metallurgical Engineers.



SAFETY CABLE TONGS

Weighing Hoppers and Scales

A New Tool for Precise Concrete Control

By P. M. Tebbs

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In Five Years the proportioning of concrete materials by weight has become familiar practice and has produced a new type of equipment. Aggregate weighing hoppers and scales, usually combined with special bin construction, are produced by a number of manufacturers. Because of its youth, weighing equipment is in a formative stage. It also is still uncertain what the requirements and operating procedure should be. In this article, therefore, the construction engineer instead of the equipment producer has been selected to develop the discussion of concrete batching and weighing equipment. Without trespassing on the manufacturer's prerogative of developing the mechanics of his equipment, its requirements are presented against a background of its development up to the present. An article inspiring alike to the producer and the user is the result. The author is surpassed by few in his deep study of his subject.
—Editor.

PRIOR to 1919 practically no thought or study had been given by highway engineers or contractors to improving the equipment or methods utilized in the proportioning of aggregates entering into concrete road construction. Wheelbarrow batching from the subgrade had been the accepted practice and was an inheritance of a relatively new industry from the general construction field. This crude method, which had been the cause of many misunderstandings and poor pavements, was eliminated by the change in highway specifications which provided that batch boxes or compartments of the exact volumetric size must be employed and no aggregates would be permitted on the subgrade within a stated distance from the paving operation. Many contractors reacted unfavorably to this radical change, not desiring to junk a dozen or more "perfectly good and nearly new wheelbarrows."

The results expected from the new specifications were: (1) improvement in the accuracy of proportioning, (2) elimination of contamination of aggregates, and (3) reduction of hand labor.

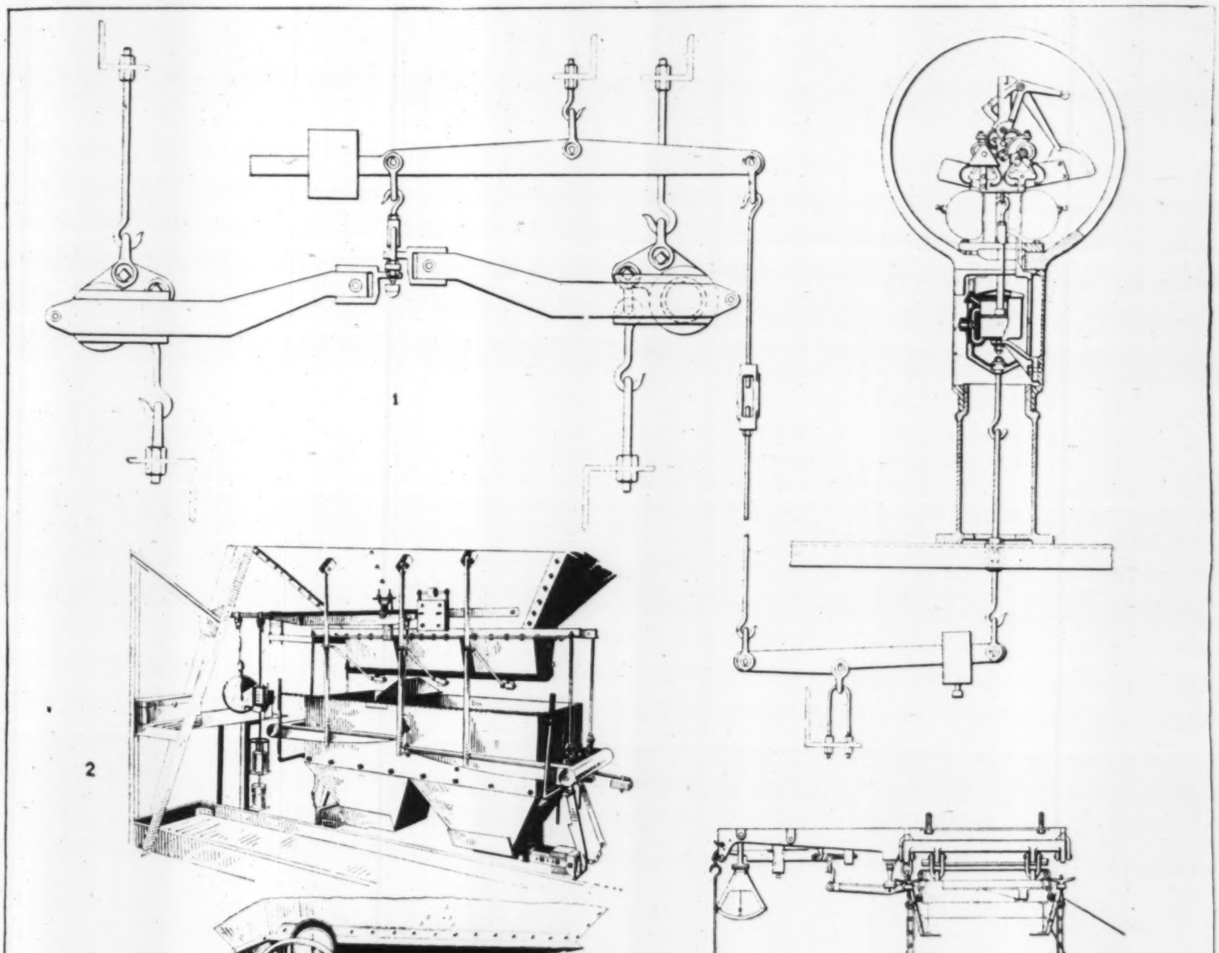
The first equipment furnished to meet the new requirements was an assortment in which carts, wagons, bins, platforms, trucks and batchboxes played a part. From this chaos there developed the standard portable bin, with its measuring hopper adjustable to the required volume and with interlocking gate controls to forestall careless operation, and the use of cranes for loading and unloading aggregates. Contractors at that time considered this an unwarranted expense, but changed their minds very quickly after results showed more efficient operation and increased production.

Engineering Demand Forced Invention

The lead in formulating this policy had been forced upon the engineer by the necessity of reform in the proportioning of aggregates. It placed him in a field which had been considered previously as purely the contractor's. With the completion of the refinements in design and construction of the volumetrically controlled bins and batching plants it was felt by the engineer that everything had been accomplished which was expected when the specifications were changed. A more far-reaching result, which had not been anticipated, was the formation of an efficient equipment group, which increased not only the accuracy and workability of specification requirements, but, still further, the speed of production and the general efficiency of contractors' operations.

It was soon discovered however, that there was still room for improvement in the accuracy of proportioning aggregates on account of the bulking of fine aggregates due to the variation in moisture content. It was very difficult to provide an equitable adjustment, under volumetric control, to eliminate this condition satisfactorily. The highway officials of Iowa, who were investigating continuously to secure the best methods of utilizing a poor local supply of gravel which contained a very large proportion of sand, were the first to adopt the gravimetric principle of proportioning aggregates. The present era of weighing of batches received its baptism on the C. F. Lytle Co. contract in the vicinity of Sioux City, Iowa, in 1922. The weighing equipment on this job consisted of home-made steel hoppers suspended on a springless dial scale. A central mixing plant was used and the vibration of the mixer below the bins and scales caused the needle on the springless dial to dance to such an extent that great difficulty was experienced in securing accurate weighing. However, this initial performance was fairly satisfactory and the contractor showed an excellent progress record.

During the same year in one of the eastern counties of Iowa another weight-measuring plant was being constructed. It consisted of an ordinary platform scale of the portable type, mounted on a platform beneath the bin openings, with a wooden box set on the platform of the scales, which had a hole cut through the platform so that the material, after being weighed, could be dropped through the opening in the scale platform into the truck. Two portable-type platform scales were required. During 1923 and 1924 practically all of the weighing equipment was home made. Contractors purchased scale equipment from weighing scale manufacturers and adapted it for use at proportioning plants to the best of their ability. Weight proportioning was not specified on the first few jobs upon which it was used, but later, in 1923, the Iowa State Highway Department specified measurement of aggregate by weight. Immediately thereafter the design and construction of weight-batching equipment were undertaken by enterprising manufacturers. The first devices were manufactured and sold in 1924, and although they worked, they were awkward and susceptible of great improvement.



TYPES OF BATCH-WEIGHING HOPPERS AND SCALES FOR PROPORTIONING CONCRETE

(1) Modern hopper suspension scale. (2) Assembled weighing hopper with steel stock bins. (3) Weighing batcher with double scale beam. (4) Single hopper weighing batcher. (5) Duplex weighing batcher.

Much credit must be given to R. W. Crum, former engineer of materials of the Iowa State Highway Department and now director of the Highway Research Board, who was the first man to see the advantages to be gained by weight measurement and had the courage of his convictions to place the system in actual operation. Despite the many hindrances and drawbacks in the early stages of development of equipment for this system of measurement, Mr. Crum continued his research and experiments and his name should go down in engineering history as the man who started this advanced movement for the more accurate and equitable system of the measurement of aggregates for concrete construction. As soon as other highway engineers saw the practicability and advantages of weighing they indorsed the movement and incorporated it in their specifications. The U. S. Bureau of Public Roads now makes weight measurement compulsory on all federal-aid projects. Its use has spread also to all types of general construction, and today it is practically a standard method of measurement.

The more progressive engineers continued to demand certain improvements and refinements which the manufacturers were ready and willing to furnish, and as a result a fairly creditable line of weight-proportioning equipment is available at present. As is usually the case when the engineer starts a study along any line, he learns and accomplishes more than he anticipated. While experiments in more accurate proportioning were being worked out, naturally the resultant concrete was being studied. It was soon observed that weight-proportioned concrete had better strength and much greater uniformity, notwithstanding the fact that there had been an addition of from 10 to 15 per cent of sand. The net result has been the addition of a corresponding amount of coarse aggregate, producing a more efficient and economical mixture. Contractors have been eager to adopt this method on account of reduced quantity of cement and less overrun of this material, due to more accurate proportioning.

I have stressed the fact that the development of this equipment up to this time had been evolutionary. There had been no standard specifications for it during this period, and as a result some engineers were demanding one thing and some another. During the past year two committees, one of the American Association of State Highway Officials and one of the American Road Builders Association, have by joint action practically agreed to specifications for the standardization of weight-proportioning equipment. The state highway official is interested mostly in the bin-batcher proportioning plant, while the A.R.B.A. interest includes the manufacturer and city paving and therefore the large central mixing plants. The A.R.B.A. standardization includes the fundamental requirements for all types of weight-proportioning equipment.

Bin, Hopper and Scale Requirements

The bins, including bin supports, are not so vital in weight proportioning so long as they are sufficiently tight to hold the aggregates without leakage. The supports must be sufficient to provide inflexible support for the weighing mechanism, and the entire structure must be mobile as required. The bins must be supported by a substantial foundation.

The hopper in which the aggregate is to be weighed is a most essential part of the equipment. It must be entirely supported on the scales and otherwise free. The hopper and its supports must be designed and constructed so as to provide the least practicable space for the accumulation of materials that will add to the tare weight of the hopper. Any hopper which has any horizontal angle supports or stiffeners does not meet specification requirements and should not be used. Any defense of such a piece of equipment is reactionary. Preferably the hopper should not have any angular corners where material may adhere and add tare weight.

The vertical cross-section of the hopper should be designed for quick and complete discharge under all probable conditions of the material to be weighed. Any sloping sides should be provided with sufficient clearance under the bin gate or with a side opening by which overload may be removed readily. It is recommended that provision be made for volume adjustment of the hopper as a check on or indication of variation in the weight or volume of the aggregate. The volume check will indicate overweight and limit it. In the case of considerable variation in the grading of aggregates, the variation in the volume for a given weight will be noticeable.

The hopper gates should be designed for reasonable tightness when closed, quick discharge and closing. The arrangement of the batcher doors must be such that each aggregate can be discharged separately for checking and inspection. The hinged, drop type of gate is usually closed by counterweight and held by latch or controlled by a lever and held by a toggle. Care must be exercised in providing underclearance for all moving equipment beneath when such gates are open. The sectoral type and horizontal pivoted gate are also used with success, the former being most readily automatic in the closing operation. Interlocking gate controls, by which both the bin gate and hopper cannot be open at the same time, are advisable and will be developed. The whole hopper design and operation should result in a minimum amount of vibration to the scales which support it, in order to preserve accuracy, adjustment and endurance.

The scales must be supported from the bins in such a way that they will not be thrown out of adjustment or one part of the scale mechanism be subjected to movement independent of another part, and that the necessary free movement of all parts will be assured. It seems that a four-point suspension of the whole scale mechanism in a frame arranged for leveling would be best. The scales may be of either single-beam, multiple-beam or springless-dial type.

The maximum allowed working error in the scales is 0.4 per cent—that is, 4 lb. in 1,000. The accuracy of the new equipment should be well within this limit—in fact, within half this limit—which has been set for the rejection of old and obsolete weighing equipment.

The telltale dial feature on the beam scale is an advantageous innovation. When the batch weight is approached, an auxiliary telltale dial or beam comes into operation for the last 200 to 400 lb. of the batch. This indicates the approach of the proper amount of the batch, and the operator is thus warned to cut off the bin flow at the proper time. In case of overload, the telltale shows the approximate quantity of it.

In some states the highway departments have specified division of coarse aggregate into two sizes to correct segregation. Storage bins and weighing batchers have been developed and are already in use to handle the three aggregates.

The arrangement of the whole equipment must be worked out to facilitate operation. The gate controls must be located so that the operator can handle them and at the same time, in a comfortable posture, see the scale beams or dials. The tops of the hoppers must be in plain view and the opening for removing excess load must be reached from the operation side rather than from some place around the corner. As far as practicable, the scales should be inclosed so as to keep them free from dirt and to insure against tampering with any parts which will cause any change in the correct weighing of the aggregates. The inclosing of the scales parts must be accomplished so as not to obscure from view or render inaccessible parts which should be inspected visually or cleaned.

Operating Checks and Control

It now becomes a duty to operate and check the operation of the equipment, with a view to keeping it in first-class condition. The scale must be checked for balance five to ten times a day. It must be checked with certified test weights once a day. This operation should be performed preferably in the morning before work is started or in the evening after work is completed, or at some time when the paver is not working in order that there may be no delay in concreting operations.

It is very seldom that a commercial scale is available, where a batch can be checked for weight with any reasonable degree of accuracy. Commercial scales should not be used to check batch weights unless they have been tested recently in a manner which would provide a positive assurance of their correctness.

Continuous checking to eliminate error is an absolute essential in maintaining accuracy. Having checked the mechanism and found it correct, we arrive at the much more difficult problem of attempting to solve the "human equation" as represented by the operator and inspector. In the first place, it must be recognized that the continuous operation of a batching plant is extremely monotonous and not conducive to mental alertness. For this reason, I favor a signal bell to indicate the approach of the full load. Bringing the sense of hearing into the operator's faculties in addition to sight or the mere watching of dials or beams is a distinct asset. It is a signal that a function is accomplished and represents the beating of time for the systematic operation of the organization concerned. It would also enable the superintendent, knowing the time element involved for batches going through the mixer, to check this same factor at the proportioning plant without the knowledge of the men operating the plant.

In the operation of any human-controlled machine it is useless to check any operation features if advance notice has been given. Any man who has been an observer on a construction project where the varying human characteristics of many operators play such an important part knows that all of the batches leaving the plant are not within the allowable error of 0.4 per cent. The scales may vary during the day, and other occurrences, such as freedom of the flow of materials, a waiting truck, the call of a fellow workman, all have an influence upon the batch which is difficult to determine accurately, and require constant concentration to eliminate, proving conclusively that every possible mechanical safeguard must be provided to insure this most necessary accuracy. Regardless of this mechanical perfection, every effort must be exerted by contractor and engineer to provide the highest type of men for operation and inspection.

I have covered the weighing plant of the past and present. The plant of the future must possess all of the present mechanical perfections, including interlocking gate controls and advance signal alarm, which features have already been discussed. Engineers of the manufacturers must also develop a recording device to show the overrun or underrun of materials for each day and the total material used, and an automatic cutoff control which has proved so essential to accurate and uniform results in commercial weighing and bagging machines.

The manufacturer will meet and overcome these problems, as he has others. The increase in progress and efficiency of road construction has been synonymous with the progress in manufacture of roadbuilding equipment. The efficiency of such equipment has always been superior to the control and operation of it. Very few if any highway constructors have been able to operate their equipment at maximum or even average capacity for any sustained period of time. It is the most pressing problem that must be solved by highway engineers, manufacturers and constructors so that all equipment may show still greater returns on the investment.

With such a satisfactory past and gratifying present record, we may look forward to the future with the utmost confidence that the progress in the efficiency of roadbuilding equipment, and especially weight-measurement plants, will continue with the thoughts of increasing production, decreasing costs and a better finished product foremost in the minds of all those intrusted with the development of the highway industry.

What the Engineer Lacks—As Seen by a Lawyer

FAILURE of the "vast majority of engineers to cultivate speaking ability" is stressed by Ralph G. Lindstrom, a Denver attorney, in the January-February *Engineers' Bulletin* (official organ of the Colorado Society of Engineers) under the heading, "An Engineering Omission." Says Mr. Lindstrom, in part:

"The very fact that engineers' ideas do find subsequent translation into completed objective expression through construction, because construction ability is cultivated as well as the ability to conceive and consider engineering ideas, is proof that the engineer can, if he will, cultivate also the ability to stand on his feet and translate his ideas into such clearly expressed speech that those of us who do not enjoy engineering consciousness can, at least in reasonable degree, visualize and test the feasibility and advisability of projected public engineering improvement, from a business standpoint.

"Engineers must no longer shirk the responsibility of cultivating facility in the matter of public expression. They must recognize three steps in any public engineering project. The first step is conception of the proposal. The second step is disinterested engineering information to the public. The third step is construction of the project. I submit that the second step is in large part neglected because engineers have not, save with all too few exceptions, cultivated the ability to speak in public.

"Possibly engineers have prided themselves on scientific and logical subjective consideration, tested only by the fruit of the finished project. But where the public is concerned, because an engineering project is a public venture, the authorization will never be made by a thoroughly intelligent, because informed, electorate, unless engineers accept the responsibility of disinterested engineering information publicly expressed. His increasingly important place in the affairs of mankind must awaken the engineer to his duty to be also a public speaker."

Hoist Progress From Single Drum to Seven

A Many-Function Construction Tool

By F. D. Hooper
Sales Manager, Lidgerwood Manufacturing Co., Elizabeth, N. J.

The Construction Hoist is very nearly a universal tool. It is old among the tools used by the constructor. Its progress from the winch has been a series of accretions in size, weight, applications of power, refinements of mechanical design, materials and workmanship and multiplication of control devices, without radical changes in functional characteristics. All these facts have led to its acceptance by engineers as commonplace equipment—scarcely meriting notice in the accumulation of giant power excavators, concrete construction plant and conveying and transporting machinery that has crowded constructors for attention since the Chicago Drainage Canal sublimated equipment in American engineering construction. This article, by a pioneer among hoist designers and builders, brings into clear vision the construction hoist as one of the commanding developments of equipment engineering. —Editor.

Evolution of the modern hoist from the hand-operated winch, centuries old, has been a step-by-step conversion of faulty design to dependable construction; of wasteful practices to efficient methods. Around 1874 the hoist was a cranky, one-drum one-winch-head machine. In operating a derrick, the load was hoisted by the drum and the boom was either fastened in place or raised and lowered by the winch head, requiring the use of an extra man. The boom was swung by a tag line and was pulled around by another man. The cone friction drum added much to hoist dependability; the introduction of double-drum hoists, lifting the load and topping the boom at the same time, added speed to derrick work, and the invention of boom swinging gear gave the hoist engineer complete control of derrick operations. With these fundamental problems solved, the way was cleared for refinements in design.

Development of Power Unit

Early hoisting engines were, of course, steam driven, and two types were in use: (1) the theoretically ideal rotary engine, with inclosed wearing parts and no dead centers, and (2) a single-cylinder reciprocating engine which was given to stopping on dead centers. The rotary engine did not prove generally successful. Comment from the field, ranging from such remarks as "it takes a 10-hp. boiler to run a three-cat power engine" to the plaint of a coal mine operator that he would like to operate a hoist which would lift more coal than it would consume, caused a concentration of thought on reciprocating engine improvement, which resulted in a superior design. Later the double-cylinder hoist displaced the single-cylinder; electric motors entered into competition with steam, and after some years the gasoline engine offered a third choice to the contractor searching for the power best suited to his needs.

The outstanding change in the field of contractors' hoists is in power source. Out of every hundred modern hoists in the contracting field, 60 are powered by gasoline engines, 21 have electric drive and 19 are steam driven. While no national figures are available, it is likely that they would vary but little from the data offered here. Gasoline hoists account for 42 per cent of the annual expenditure by contractors for new hoisting equipment; electric hoists, 33 per cent, and steam hoists, 25 per cent. It is interesting to compare these figures with the general averages for all hoisting fields. This is done in the accompanying table. It would appear from these figures that the American contractor places a great deal more dependence upon the reliability of the modern industrial gasoline engine than does the foreign brotherhood. It should be noted that the commercial gasoline power unit has been developed to a point where it is to be relied upon for good and efficient service; but for service where sudden and very considerable overloads are to be experienced it has not the same adaptability as the double-cylinder steam hoist, the series direct-current motor or the alternating-current induction motor.

It seems to be current practice in the United States to allot to the steam and gasoline hoist the work done in less populous districts. Direct-current hoists, which are most nearly comparable to steam in performance because of overload capacity at slow speeds, are limited to the few localities where direct current is still available. Alternating-current hoists, with crane and hoist type slip-ring motors, are applicable in towns and areas where alternating current is available. With the gasoline or steam hoist, the contractor need not worry about the power supply on future jobs.

	Electric	Gasoline	Steam
	(Per Cent of Annual Purchases)		
Construction (domestic)	33	42	25
Construction (foreign)	38	12	50
All fields (domestic)	56	23	21
All fields (foreign)	29	12	56

Improvement of Hoist Mechanism

In the development of hoists it has been found that it is not wise to sacrifice the rugged simplicity of the machine, but rather to add thereto certain improved features of demonstrated value. As a result general-purpose hoists show few radical changes in design. In general it is to be noted that rope speeds have been increased, drums hold more cable, asbestos fabric-type brake linings have displaced wooden blocks, gears are generally of steel with cut teeth instead of cast iron and gears are guarded more effectively. Brakes are usually located on the end of drums opposite to frictions, thereby

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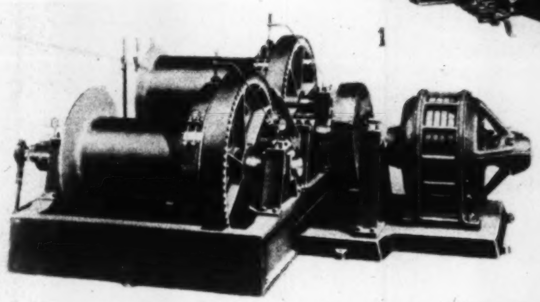
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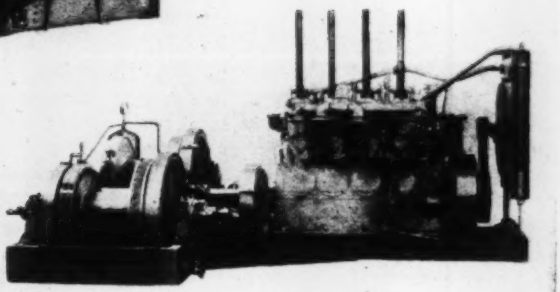
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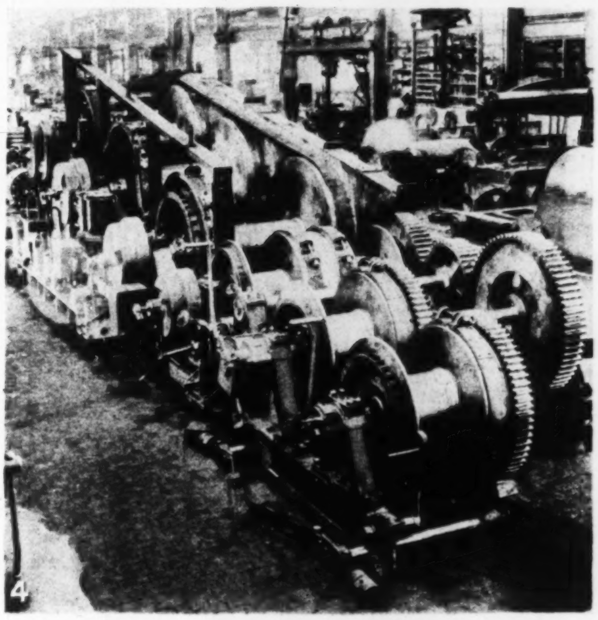
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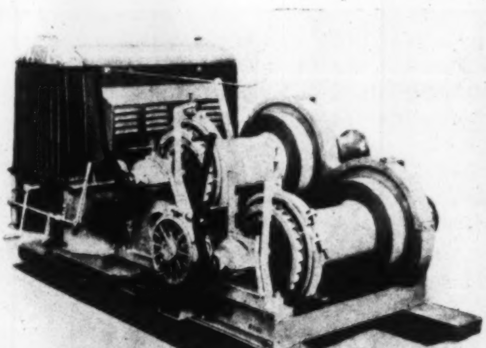
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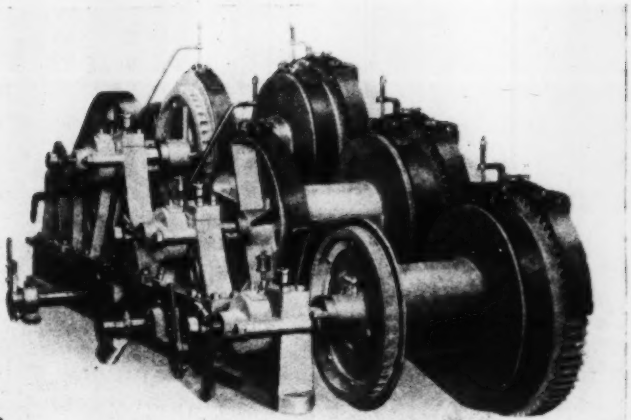
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TYPES OF MODERN CONSTRUCTION HOISTS

(1) 400-hp. electric cableway hoist, Owyhee dam. (2) Electric drag scraper hoist. (3) Two-speed slack line cableway excavator hoist, 120-hp. diesel. (4) Seven-drum bridge erection hoist for 100-ton loads. (5) 50-hp. gasoline hoist. (6) Three-drum electric hoist for two-line bucket work.

keeping the heat generated during braking away from the friction flange and avoiding distortion of this flange due to expansion. For certain types of service where frequent slipping occurs, asbestos-molded blocks are proving an advantage. Rigidity of the bedplates and side stands and the alignment and lubrication of bearings have been improved.

Standardizing Production

Early hoists were all-purpose hoists. With the coming of specialists in construction work, the demand for specialized hoists led to an era of custom-built hoists, the contractor figuring that hoists closely adapted to his particular conditions would soon repay him the extra cost of built-to-order production. The present trend is toward a standardization of sizes and duties where possible, with the consequent economic advantage of quantity production. Working from the data supplied by the built-to-order hoists, manufacturers have found the average rope pulls and rope speeds desired in general construction hoists and today build in quantities, in advance of demand, such standard sizes as 7x10-in., 8¼x10-in., 9x10-in., 10x12-in. and 12x12-in. steam hoists and 15-, 20-, 30-, 40- and up to 125-hp. hoists adaptable to either gasoline or electric drive.

Many of the general-purpose hoists below 50 hp. are built as single-drum units. The contractor may buy a second drum unit, and, above 20 hp., swinging gear, adding and removing the extra units as his work requires. One class of hoisting, high-speed material elevating, does not line up with general-duty ratings, and several manufacturers carry in stock gasoline and electric hoists around 30 hp. which lift a platform and two loaded wheelbarrows at a speed of 500 per minute.

Drag scraper hoists have also reached a fair degree of standardization. All such hoists are double-drum, the front drum being of comparatively small diameter for powerful inhauling of the bottomless scraper bucket, the rear drum of large diameter and geared to provide a fast return of the bucket to the digging point.

Heavy-Duty and Special-Purpose Hoists

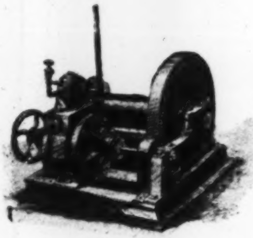
In the field of heavy-duty hoists, from 50 to 125 hp. and up, advances in design win quick acceptance by contractors on the lookout for faster, safer, more easily operated hoists. The usual step-up of gasoline heavy duty hoists is 50, 60, 80, 85 and 100 hp. and in electric hoists about the same, with an additional type mounting a 125-hp. motor. A short time ago such hoists were "specials"; today the contractor not only buys large hoists but expects such standard equipment as auto-mechanical or solenoid brakes on electric hoists and auto-mechanical jack shaft brakes to prevent gasoline hoists from backing down under load. A composite picture of the modern standard heavy-duty hoist would include wide, capacious drums, brakes mounted on flanges opposite the friction flanges, and compact lever arrangement so that even three-drum and swinging-gear hoists are operated from one position.

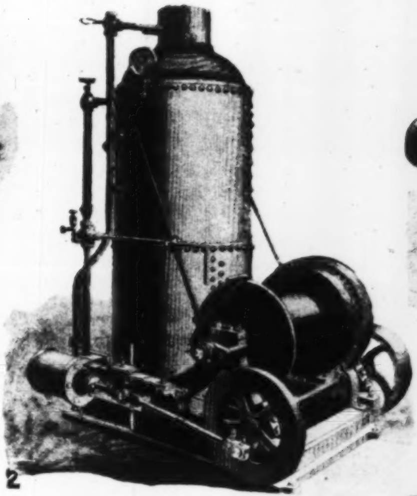
In the interests of increased portability, manufacturers are frequently using welded structural steel bedplates. Such hoists are usually built as single-, double- and three-drum hoists, frequently with silent chain drive, fully inclosed, from motor pinion to a jack shaft between the first and second drums on multiple-drum hoists, in front of the drum on single-drum hoists. This design gives both first and second drums direct drive, and since both drums wind over, swinging gear units may be installed without introducing a pinion between the two drums. Self-starting equipment is now made available by the motor manufacturers for the larger sizes of gasoline hoists. The gears of third drum units usually mesh direct with the second drum gear, although an interposed-pinion, bringing the rope lead to the top of the drum, is provided if the contractor expects to use a swinging gear at times. In this case the entire outfit is equipped with levers at the side, hand friction, foot brake, or extension levers banked in a rack located at the point of greatest operating convenience.

In the field of excavation, for operating clamshell and orange-peel grab buckets, for land use on skid excavators and for floating service, three-friction-drum hoists are used. These have swinging gears in the smaller sizes and separate swinging hoists in the larger units. The separate swinging hoist is usual in floating rigs because of the increased power needed, due to the list of the barge when the boom is overside. The bucket hoists are especially rugged machines. The rear drum is usually the boom drum and handles the rope from the topping lift. A gear loose on the shaft has some advantages, as it obviates turning this drumshaft in the drum when the boom is "dogged" or held by the brake when hoisting on the middle and forward drums. The middle drum is usually the holding drum and has two heavy brakes, while the front or closing line drum has only one brake or sometimes not any, depending on the preference of the operator. These bucket hoists are provided with a substantial mechanical automatic non-reversing brake on the intermediate or motor shaft. The usual sizes run from 75 to 125 hp., but lately these hoists have been built up to 300 hp. In the very large size hoists, direct air thrusts on the drumshaft are a recent development, and are of great advantage, as they set the frictions by direct air thrust and the operator is relieved from fatigue, as he simply operates the small air pressure regulating valves. The brakes may be set manually or they may be weight set, air released, as may be desired.

In the field of building erection is the steel erector's hoist, usually a two-friction drum machine. These hoists operate derricks for handling and setting steel, one or more being used depending on the size and type of construction work to be done. These hoists are heavy-duty type with drums of liberal rope capacity with ample brakes and heavy drum shafts. The tendency is toward hoists operated by electric motors up to 150 hp., although many steam hoists with boilers are still employed and some contractors are employing gasoline hoists of 60 to 100 hp.

The special safety brake described in a succeeding paragraph was developed for the steel erector's hoists. Single-friction drum, high-speed hoists, electric and gasoline, are used for handling material elevators. These elevators are used for incidental material such as brick, hollow tile, plumbing fixtures, and sometimes, in larger sizes, for concrete buggies. These hoists are specially designed for high speed both in hoisting and in lowering. Two brakes are usual on the drum, as the braking duty is very severe, the operator frequently allowing the elevator to fall almost free until near the ground, when the brakes are applied suddenly to bring the elevator quickly to a stop. Because of the high hoisting speed, 600 to 1,500 ft. per minute, these hoists are usually designed with a single ratio of cut steel gearing. Bakelite or fabroil pinions are sometimes employed, as they tend to produce quiet running, but this is determined by the duty, as they have not the strength of forged steel. The latest hoists of this type have motors up to 125 hp.

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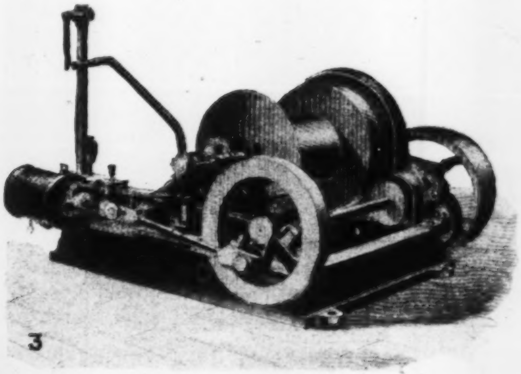
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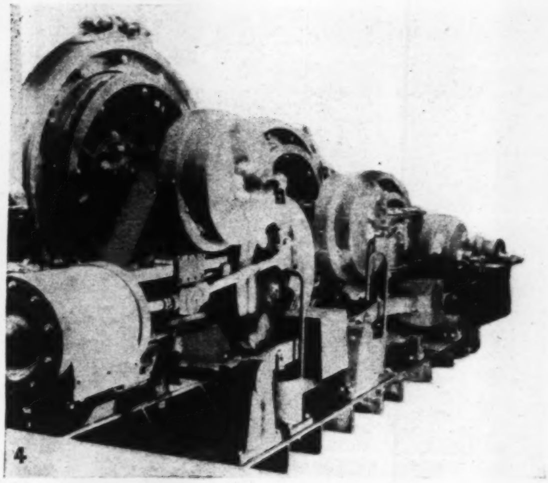
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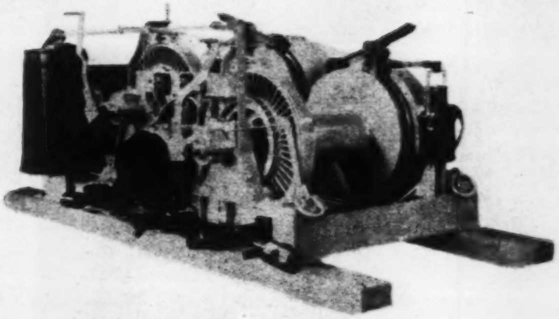
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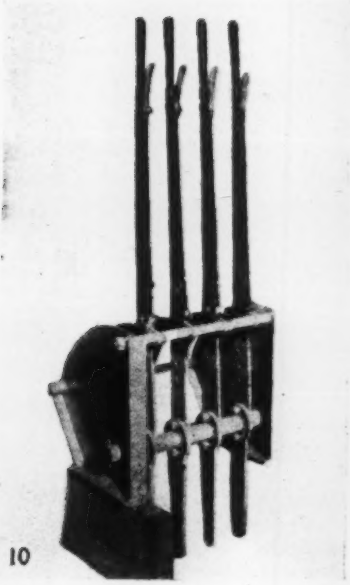
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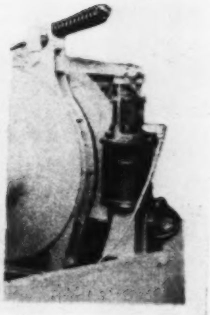
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EARLY HOISTS AND MODERN HOIST DETAILS

(1) Rotary hoisting engine. (2) One-cylinder, one-drum steam hoist with boiler. (3) One-cylinder, one-drum hoist with belt pulley. (4) Close-up of pneumatic friction set-ups and weight-set, air-released brakes. (5) Steel erector's high-speed safety hoist. (6) Solenoid brake for electric hoists. (7) Auto-mechanical brake for electric or gasoline hoists. (8) Pneumatic friction and brake control valves for large cableway hoists. (9) Emergency brake for high-speed erector's hoist. (10) Adjustable push or pull lever-quadrant stand.

Single-friction-drum hoists are also now coming into extensive use for operating concrete buckets in special towers employing chutes for distributing the concrete. Sizes usually run from $\frac{1}{2}$ to $1\frac{1}{2}$ cu.yd. and motors from 50 to 125 hp., although larger sizes have been developed.

The power limits set by contractors in search of low-cost material-handling equipment seem to be the blue sky, as witness new "tops" recently established in the special hoists of an 120-hp. diesel slack-line excavator hoist, 12x12-in. steam hoists for 100-ton loads in bridge erection and a 400-hp. electric cableway hoist. Diesels are a success in logging and if the power demand curve of hoist users does not flatten out soon, the diesel may become a factor in hoisting power units.

Operation of the superpowered hoists is surprisingly easy. In the 400-hp. cableway hoist on the Owyhee dam, the operator is located at a point about 500 ft. forward of the hoist and 300 ft. below it. Moving a 4-in. lever opens, by electricity, the valve to the pneumatic friction set-up, which presses the drum against its friction blocks. Moving the lever in the opposite direction releases the friction. Application of drum brakes is equally easy, the electrically operated valves being controlled by switches similar to the friction switches. Brakes are weight-set, cushioned by a dashpot arrangement and are released by pneumatic pistons. The usual method of controlling pneumatic friction set-ups and brake release pistons is to admit and release air by direct-acting valve levers grouped at the rear of the hoist. The two-speed cableway hoist is a new development in this field, although a different method of obtaining two-speed operation has long been in use in the slackline cableway excavator hoist.

Progress in Safety Devices

Interest in and contributions to safe hoisting practice reached a new high point in 1929. First came the development of an automatic cut-off system to stop conflicting signals to the operator of material elevator hoists. In the system devised by Detroit contractors, an open tower gate cuts off signals from the other floors.

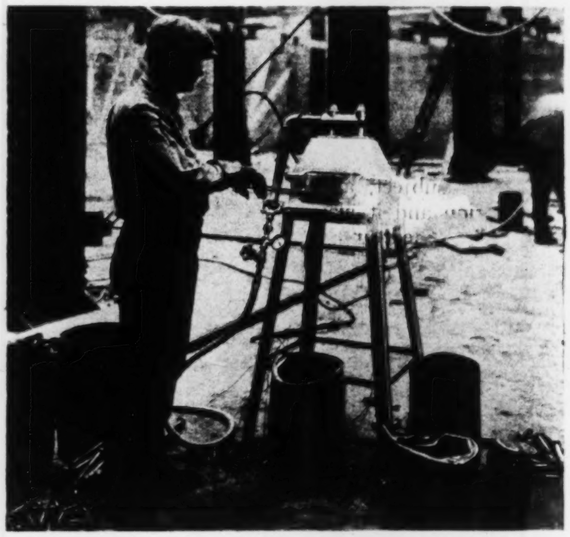
The second development was the result, as is quite often the case, of suggestions received by the manufacturers from the users. The principal danger of erection hoisting is a blown fuse in the current supply system. The hoist engineer, too, is subject to all the ills to which human flesh is heir. The adaption of an electro-hydraulic operator to attend to the instant application of hoist emergency brakes in a crisis, without human intervention, represents a real advance in safe hoisting methods. As long as power supply is maintained to the fractional horsepower motor on top of the hydraulic operator, oil pressure against a piston holds the emergency brake clear of the drum. Failure of power supply withdraws the pressure and brings the spring-set emergency brake into action, the hydraulic operator supplying a remarkably smooth and fast dashpot action which eases the strain on cables and lines.

This eliminates the blown fuse as a trouble maker. The other contingencies are provided for by wiring the small motor through a normally open switch at the foot brake lever and normally closed hand switch within easy reach of the hoist operator. The action of stepping on the foot brake lever closes the roller switch, which releases the emergency brake and permits the engineer to go about his accustomed work. Removing pressure on the foot lever for any reason interrupts current to the hydraulic operator and the emergency brake is applied. The hand switch is for the operator's use in voluntary application of the emergency brake. It will be seen that this safety feature actually speeds up routine hoisting, as the emergency brake serves to dog the drum and no release lift is necessary, as is the case with the conventional ratchet and pawl.

Summing up, the construction industry is definitely increasing the speed, power and safety of its hoisting equipment. An appreciable acceptance of the standardized hoist has been built up in the last two years. For much of this progress, manufacturers have to thank contractors. Hoists, designed to suit one contractor's needs, often fit into modern hoisting requirements so neatly that the type is elevated to a place in the catalog and given a catalog number. For accuracy, the catalog number is thereafter used to designate the type; unofficially, the name sticks.

Gas-Fired Rivet Heaters on a New York Building

FOR the erection of the steelwork on the Consolidated Gas Building in New York City it was thought advisable, inasmuch as the Consolidated Gas Co. is a manufacturer of gas and a distributor of gas appliances, that all heating be done by illuminating gas. Accordingly, gas-fired rivet heaters of the type shown in the accompanying illustration were used. The gas flame was injected through the top. The gas had been compressed to about 7 lb. per sq.in. and in passing through the mixing chamber had united with a certain amount of air. The remainder of the air required for combustion was drawn in through an opening in the rear of the furnace.


HEATING RIVETS WITH ILLUMINATING GAS

The large volume of the furnace permitted many rivets to be heated simultaneously, and the man in charge had a good view of all rivets at all times. Smoke and dust were entirely eliminated. The biggest disadvantage of the furnace was a deafening roar caused by the gas blowing out the front. It was necessary to have gas pipes and hose erected and extended to each furnace. The riser was carried up with the steel erection and a single horizontal pipe laid across each floor. By using flexible hose, the heaters could be set up at any convenient location.

Portable Continuous Conveyors

Putting the Belt and Bucket Chain on Wheels

By W. B. Greene

Vice-President, Barber-Greene Co., Aurora, Ill.

The Field of the continuous bucket elevator and belt conveyor was immeasurably broadened when in 1910 they were put on wheels. By this assurance of mobility they were introduced at once into the profitable field of construction, in which in their previously immobile form they had enjoyed only limited application. For twenty years the invention of one improvement has followed another—the gasoline engine and electric motor, the crawler traction, the light truss frame and the measuring hopper have all increased mobility and applications. Today portable continuous conveyors are standard construction equipment. Their future development lies in the possibilities for lighter and faster moving machines, and the invention of further means of operation in-train for continuous, wide-radius delivery. The writer of this article discusses his subject with the authority of a pioneer inventor and a successful builder of portable conveyors. —Editor.

In former days no flat flexible material similar to our present rubber belting was known. Undoubtedly, therefore, the thought of a continuous loop of buckets was the first conception of a device in the line of a continuous conveying machine. The ancient water-elevating chain of men, identical to our present volunteer fire brigade, could easily have prompted the continuous bucket line idea.

As a thought from the past and with no intention of defining or defending the chronological order of conveyor development, there is shown here a reproduction of a drawing, found in a French museum, of one of the earliest conceptions of the modern bucket elevator, one which incidentally is closely tied to our specific s[illegible] it was designed for building construction [illegible] was crudely portable, in that it was a self-contained unit. This drawing was taken from a book dated 1578, and apparently was one of the many ideas that were conceived (not actually proved) by the mathematician Jaques Beffon Dauphonois. It is interesting to note that "Jake," as he was probably called, gave quite a job to the man at the head pulley and that he believed thoroughly in the idea of cheap construction, as he has only one gear reduction. The man at the tail pulley had the job of supplying supplementary power through a direct drive. "Jake's" mathematics evidently revealed that one man with a 10 to 1 worm reduction would require only a little more power to operate the device, and two worms would be an unnecessary expense.

Early American Belt Conveyors

According to Hetzel, the earliest reference to the use of belt conveyors in American practice is in Oliver Evans' "Miller's Guide," published in Philadelphia in 1795. This describes a flat belt, receiving material on its upper run and discharging over the end. Evans calls it a "broad endless strip of this pliant leather or canvas, revolving over two pulleys in a case or trough." In the flour and grist mills built by Evans and his successors some of these conveyors were probably used. In those days, however, it was more common to use screw conveyors to convey grain as well as the lighter mill products.

Belts sliding in troughs were used before 1840 to convey materials which were not suitable for screw conveyors, such as clay, shavings, sawmill refuse and crushed stone. In some cases the return run slid back, and in some cases it was carried on rollers. Sometimes the sides of the trough were made with hinged sections, which when placed diagonally across the belt would discharge the materials at these points, forming what are now commonly known as discharge sweeps. The handling and elevating of grain that became common in this period stimulated the design and construction of conveying systems.

Soon afterward the application of belt conveyors began to spread to many of the fields of material handling. Likewise the bucket elevator was being used in place of the belt where a more vertical elevation was required. At this time both the bucket and the belt systems were special jobs in the sense that the design and construction of each one was an individual problem.

Development of Portability

Although they were moved in some cases, the idea of practical portability was not applied to either bucket or belt conveyor design until about 1910. It proved to be more successful for buckets than for belts at that time. This was because of the fact that portable bucket loaders were reasonably light units and belts were entirely too heavy to be hand pushed to any usable extent. Portable bucket loaders at that time had to have only a comparatively low discharge clearance to reach over the sides of wagons, and together with the fact that they had no feeding device this made a light construction possible. They were mainly home made, some of them with wooden frames.

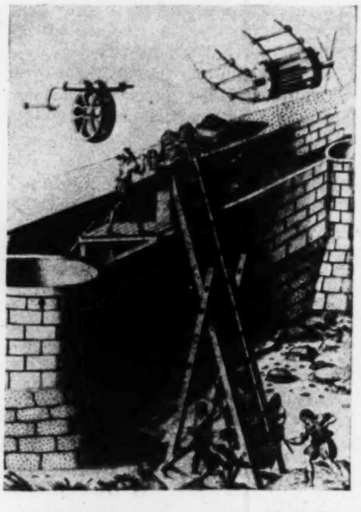
As motor trucks came into use, portable bucket loaders were necessarily made larger for higher discharge clearance. This was practicable, as the trucks backing up to the loader were used to force the machine into the pile of material. Belt-conveyor manufacturers at that time made so-called portable units whenever customers required them; however, they did not consider them thoroughly practical because of their excessive weight, even though in some cases they were propelled by hand through a crank and gear reduction.

In 1916 the first portable standardized belt conveyors to be manufactured on a production basis were put on the market. The economic need for such machines had been apparent in 1912; however, plans which had been made for their design and production were delayed in 1914 by the disorganization resulting from the World War. Although the war was a factor in delaying progress, when finally the machines were produced in

1916, the war was the greatest factor in creating an urgent need for them. The labor shortage, which became serious in 1916 and which was made worse when the United States entered the war, created an extreme scarcity of man power. The uncertainty of deliveries necessitated emergency storage, on the ground, of all materials that could be so stored. This was particularly true of coal and coke. Those who had materials to unload, store and reclaim wanted light, inexpensive, portable material-handling machines.

Formerly the use of belt conveyors was on large material-handling jobs, where the great volumes to be moved made mechanical methods profitable. On small jobs, however, the low cost of labor competed seriously with mechanical methods. Then, with the increasing scarcity and cost of unskilled labor, the consequent need for portable machines placed them on small jobs where men could be used but where the machines could work faster and cheaper. The post-war period also demanded portable belt conveyors due to the roadbuilding program, the new immigration policy and the need for small material-handling units in scattered and isolated places.

We see, then, that the economic need for these machines was felt before 1912; had they been produced then, they would have found an adequate market, which would have grown as they demonstrated their ability for cutting costs and speeding up material handling. But the war and its after effects tremendously multiplied the need, so that they were adopted very widely immediately upon introduction.



SIXTEENTH CENTURY BUCKET ELEVATOR

Development of Conveyor Mechanism

The machines which were introduced on a production basis in 1916 were limited to lengths of not over 20 ft. and were suspended from overhead tracks or mounted rigidly on two wheels. These were very promptly followed by machines with lengths up to 60 ft. and with mountings upon adjustable trucks, with masts and cables for controlling the angle of the boom. The usual practice was to have the carrying rollers troughed in some manner, preferably by using three rollers, with the two outer ones at an angle. The Warren truss was adopted with the development of the greater lengths; it gave great strength per pound of weight and is as capable of resisting a bend up as it is down, which is necessary for any type of frame subjected to the varying directions of forces applied to any long portable units, by lifting or attaching the cables at varying points.

The portable conveyor came into play not only in replacing hand power but also in replacing permanent installations. Where materials had to be conveyed great distances, long permanent installations were not the answer if flexibility was desired. The portable machines were then used in tandem, in many cases being mounted on two two-wheeled trucks, with just enough elevation in each unit to discharge into the hopper end of the next.

The need for a self-propelled, self-feeding bucket loader was obvious during this same period of reclaiming operations (although the simpler portable bucket loaders described above and the portable belt conveyors were filling a great need in this field). In 1917 the first self-feeding propelled bucket loader was built. This machine, which is shown in an accompanying illustration with the writer turning the steering wheel, was wheel-mounted, the wheels provided with power drive. There were also two small wheels to aid in steering. This machine carried on the lower or charging end a feeding device consisting of two flat disks which were driven by beveled gears from the foot shaft. The disks revolved in opposite directions, and when forced into the pile by the powered wheels, slipped into the material and carried it to the scooping buckets. Although the ideal feeding arrangement for a bucket loader had probably been thought of commonly as a positive feeder, the disk arrangement was not positive, and it proved to be a big advantage for this reason. An overload on the disks did not clog the machine; the buckets scooped all they could, letting the rest slip on the disks. In 1919 this disk-feed bucket loader carried many refinements in design, including a four-cylinder gas engine which made it one of the first, if not the first, pieces of construction equipment to use an automotive-type power unit.

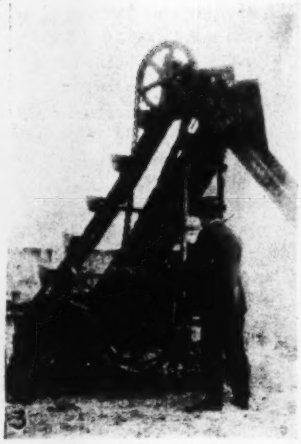
Later other power-propelled bucket loaders were brought out with other types of feeders. The present-day arrangements on bucket loaders include paddles, which are a series of staggered blades, bent like propeller blades, working on each side of the foot shaft and churning the material toward the buckets; the screw ribbon, which, as the name implies, is a spiral steel strip on each side of the foot shaft, which, like a screw conveyor, carries the material toward the buckets; and the disk feeder described above. These systems have in some cases been augmented by cutting tools, such as sawteeth on the screw type and arms carrying teeth similar to ditcher teeth on the paddle type.

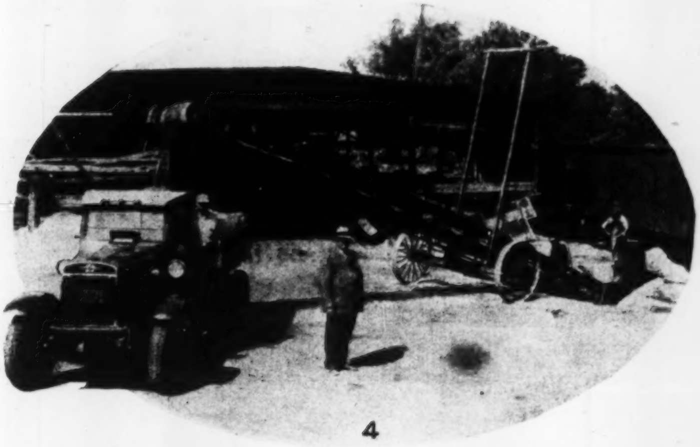
Wider wheels were the next step, to bring about less pressure per square inch on the supporting surface. Then in 1920 there came the first crawler-mounted, self-feeding bucket loader. It was, we believe, the first industrial machine to use an automotive type transmission, and one of the first construction machines, with the exception of the tractor itself, to use full crawlers. This machine carried the disk-feeding device. With its installation bucket loaders reached their present stage of perfection as far as the essential elements and principles included are concerned (not counting the various attachments which are now commonly used).

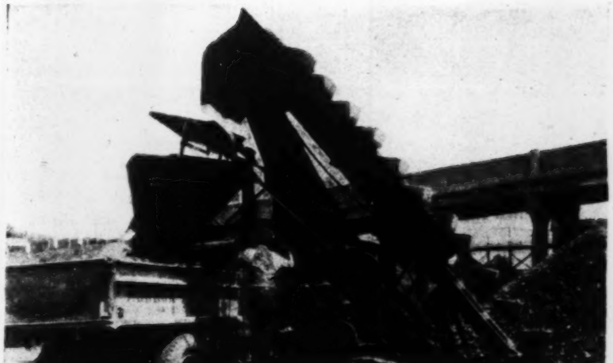
The next step was, as the others have been, quite a natural one—that of designing accessories in the form of various hoppers for proportioning the materials to be loaded, also different types and sizes of spouts and screens for screening the material as it was loaded.

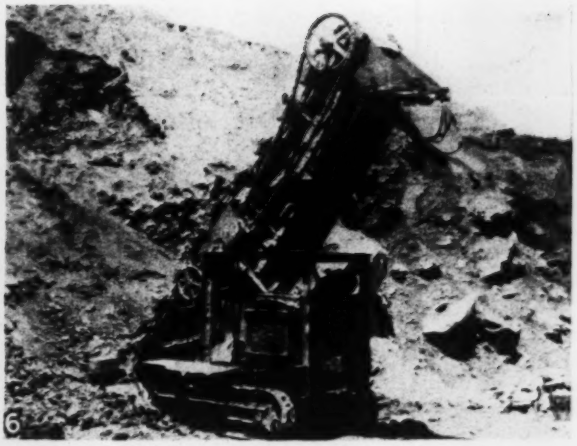
Present Use and Future Developments

The first applications of bucket loaders were mainly on road work for handling aggregate, then for handling loose subgrade material. The addition of the various hoppers increased the use of bucket loaders in the aggregate-handling field tremendously, and the manufacture and sale of these machines was on a rapid upward curve from their beginning as self-feeding, self-propelled units. The portable belt conveyor worked in perfectly with the









TYPES AND APPLICATIONS OF MOBILE BELT AND BUCKET CONVEYORS

(1) Belt conveyor stockpiling stone. (2) Early type bucket loader feeding belt conveyor. (3) First self-feeding self-propelling bucket loader ever built. (4) Typical portable belt conveyor. (5) Bucket loader with batching hopper. (6) Early crawler traction bucket loader.

bucket loaders, causing the advance storage system to be widely adopted on road construction, whether a central storage or roadside storage plant was maintained. On jobs of fairly large size two conveyors and two bucket loaders with hoppers are used, one of each machine being used on each aggregate.

In the meantime the portability of the bucket loader and the belt conveyor had spread their uses into an almost countless variety of fields. To cover the ever-growing list we should have to enumerate practically every organization that has materials to handle. Making the bucket loader and the belt conveyor portable changed their application growth from an almost vertical column that was getting higher every year to an inverted pyramid that not only gets higher but broader as time goes on.

There is one particular application in which the portable belt conveyor has made savings large enough to warrant separate consideration. It is the handling of wet concrete. This was done with portable belt conveyors for the first time, as far as we know, about eight years ago by the Walbridge Construction Co., Springfield, Ill. Here the belt carried concrete from the mixer to the forms of a large sewer being poured. Since then conveyors have been used as single units and in tandem for handling wet concrete for the construction of viaducts, buildings, locks, retaining walls, sewage-disposal plants, irrigation ditches, bridges, railroad elevations and elevated drives. The largest job of wet concrete handling accomplished entirely by portable belt conveyors is the Merchandise Mart in Chicago, where 45 portable belts were used for concrete handling only. A total of 56 belts were used on this building, the others being used for unloading and handling sand and gravel.

It is difficult to predict future developments in design and future new applications of the portable belt conveyor and the bucket loader. The inverted pyramid gets higher and broader every year, and has already assumed such great proportions that many new applications come into existence without much notice. Regardless of the mechanical improvements in view, however, these two machines have so firmly fixed themselves as fast, economical material handlers that the pyramid is bound to continue to increase in volume, any retardation being in the form of attaining slightly more vertical sides.

Alloy Steels Used in Locomotives for Mountain Service

Canadian Pacific Building Twenty 750,000-Lb. Engines of 2-10-4 Type—Oil Fuel Used

FOR HEAVY freight and passenger service on the mountain divisions in British Columbia, the Canadian Pacific Railway has now under construction twenty locomotives of the 2-10-4 type designed to operate at a maximum speed of 45 miles per hour. In producing this new type every means has been employed to obtain a most efficient machine within the weight limitations allowed. Extensive use is made of nickel-alloy steels and unit castings, the former being selected for boiler shell plates, firebox plates, arch tubes, staybolts, special castings, main rods, side rods and crank pins. Unit castings are used for the engine truck frames, four-wheel trailing truck frames, six-wheel tender truck frames, combined tender underframe and tank bottoms and for the locomotive bed castings. The latter include the entire bed or frame of the locomotive from front drawbar to the back deck plate in one piece, including the cylinders, cast integral with the frame. Each of these castings weighs 67,000 lb. and is delivered already machined for erection. Driving wheels are 63 in. in diameter, giving a nominal tractive effort of 77,200 lb.; but the first two locomotives delivered are equipped with locomotive boosters giving an additional 12,000 lb. of tractive effort. The principal characteristics of the locomotives are as follows:

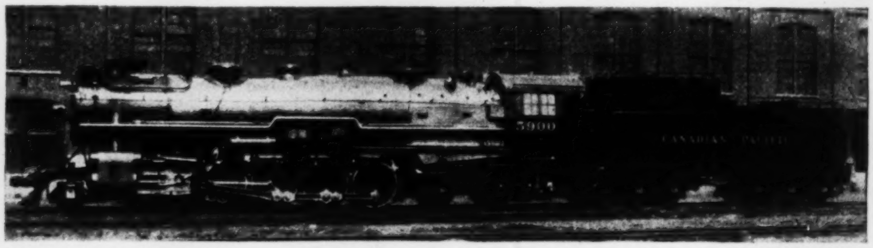


FIG. 1—CANADIAN PACIFIC OIL BURNING LOCOMOTIVE FOR MOUNTAIN SERVICE

Boiler pressure	275 lb. per sq.in.
Cylinders	25½x32 in.
Diameter of driving wheels	63 in.
Grate area	93.5 sq.ft.
Total heating surface	7,043 sq.ft.
Total weight of engine	452,500 lb.
Total weight of tender	300,000 lb.
Water capacity	12,000 Imp.gal.
Oil capacity	4,350 Imp.gal.
Driving wheel base	22 ft. 0 in.
Total wheel base	87 ft. ¾ in.
Length over couplers	98 ft. 1⅜ in.

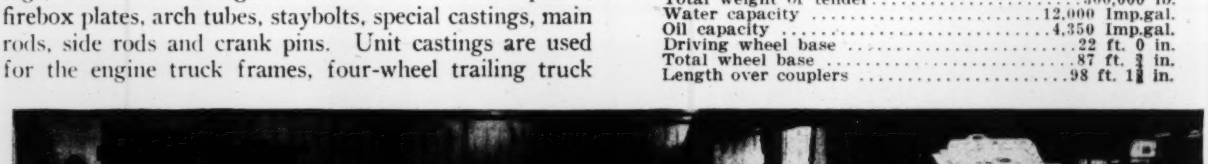


FIG. 2—CYLINDERS ARE CAST INTEGRAL WITH LOCOMOTIVE BED FRAMES
Total weight of casting 67,000 lb.

Elevating Grader and Crawler Wagons

A Well Coordinated Earth Moving Unit

By S. F. Beatty

President, Austin-Western Road Machinery Co., Chicago, Ill.

Earth Moving in the prairie states of the West owes a vast debt to the elevating grader. Wherever even ground and plowable soil prevail, this machine has for more than threescore years offered effective competition to every earth-moving device that invention has provided. Today, with separate-power belt drive and tractor operation and with tractor-operated crawler wagons to serve it, it holds as strong a position as it did in the days when the scraper was the only rival for favor in the elevating grader's distinct field. By constant improvement in materials, design and construction to meet the changing conditions, the elevating grader has kept a place in the constantly augmenting ranks of earth-moving devices. The story is tersely told in this article by the head of the firm of manufacturers whose name is virtually synonymous with the elevating grader. It is a story that warrants considered attention.

—Editor.

The first elevating grader, manufactured in 1866, was called the Wauchope. It was a wood-frame machine, and roadbuilders who are familiar with elevating grader history still talk about its dependability and the light-running qualities of its wood-frame elevator. Machines of this type were used chiefly as country road builders, and hundreds of miles of public roads were built throughout Illinois, Iowa, Minnesota and North Dakota. Up to 1877 such improvements as practical experience indicated as beneficial were added to these earliest machines. About the same time the possibilities of elevating graders on railroad construction and other earth-handling work developed. Since that time the thousands of elevating graders used by contractors in the United States are sufficient guarantee of their practicability, usefulness and economy.

Broad Steps in Elevating Grader Progress

The modern elevating grader has reached its highly perfected state by a process of development through the experience of thousands of machines in the field under all kinds of conditions. No perfect machine is produced in any other way. Its all-around efficiency is not due to the efforts of one man, or of five men, nor is it the product of one year, or of five years, but it represents the combined talent of more than half a century.

The first graders had wood axles, both front and rear, and the elevators were driven by gears in the rear wheels. The frames were straight and the carriers short, and because of this the machines were used only for casting. Prior to 1888 machines were equipped with a tumbling rod for driving the elevator, and immediately after 1888 the chain drive displaced the tumbling rod. Refined chain manufacture developed fast, and soon a point was reached where little trouble was experienced with either chains or sprockets. About 1900 an innovation came into elevating-grader manufacture—namely, a belt-drive system from a steam engine to the grader elevator. Few machines with this device were sold, however, and these only upon special order.

In 1898 elevating-grader construction changed from wood to steel, and this radical step was but one of many changes and improvements leading up to present-day models. It was not until 1904, however, that steel frames displaced the original wood-frame elevators. Steel construction was needed to secure machines impervious to exposure and various climatic conditions, as well as for additional strength.

Reversible machines were introduced for making canals and ditches on hillsides, where it is necessary to place all the earth on the bank at the lower side; and also for building levees and doing all classes of work where it is desirable to place all the material handled on one side. Arched-frame machines, and machines of longer elevator, were produced to be used as wagon loaders, because it soon became apparent that elevating graders had a much broader usefulness than for casting only.

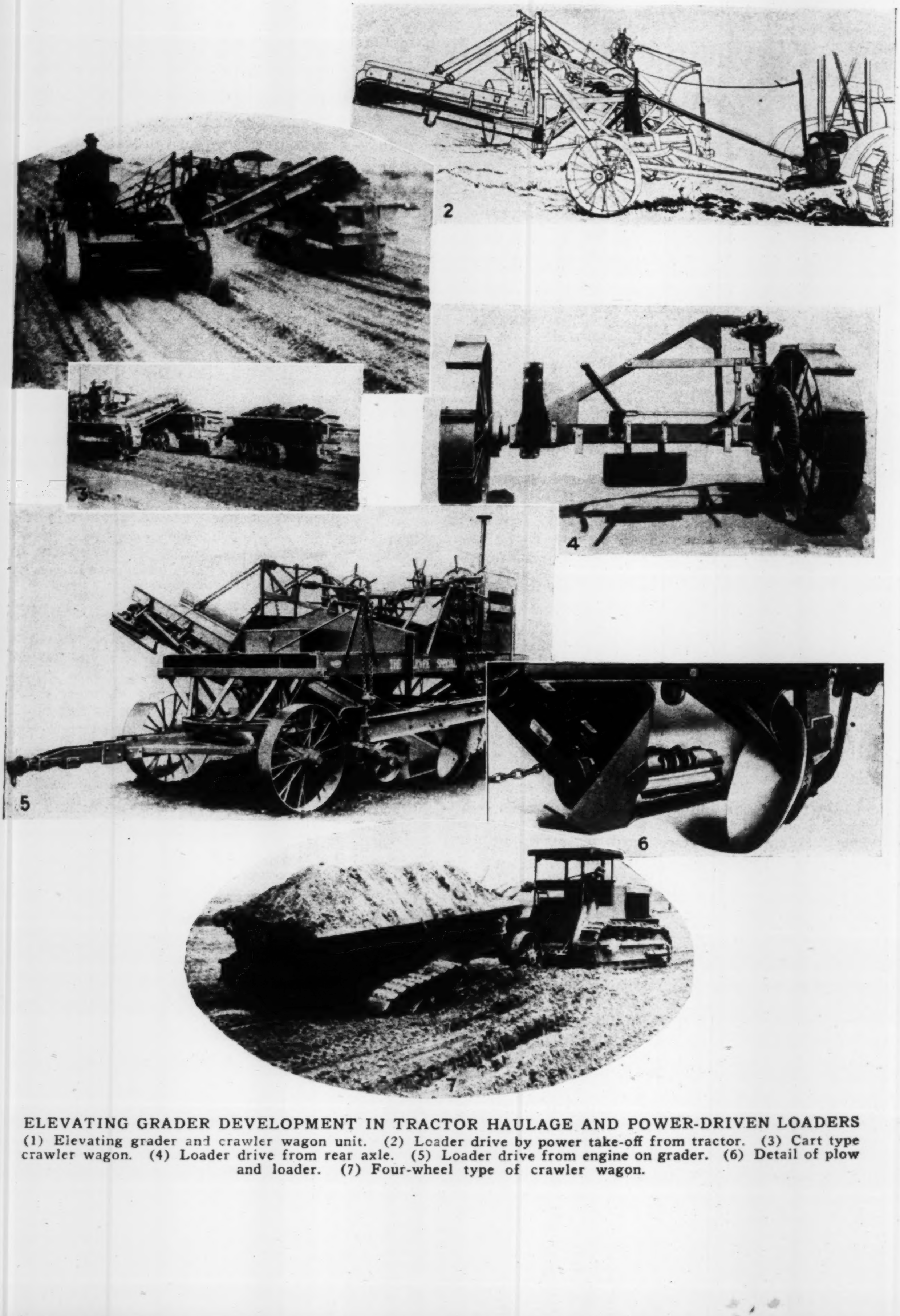
Tractor Haulage and Independent Power-Belt Drive

Until quite recently elevating graders were drawn by horses or mules, or at the most by wheel-type tractors. With the advent of the modern crawler-type tractor, greater strains were imposed than any elevating grader had been designed to bear, and since that time elevating-grader construction has been required to present a combination of extreme strength and flexibility. Minimum weight has also been an important factor in construction. Lightness, durability, strength and the necessary flexibility to allow the machine to conform to the uneven surface of the ground without straining, twisting or springing the frame out of shape are important factors in construction that have been well considered.

A chain is only as strong as its weakest link, and an elevating grader is only as efficient as its elevator. The elevator cannot deliver more material than the plow puts upon it, and by the same token the plow cannot be worked to capacity until the elevator can handle all the material the plow can cut. In the past the operator has found it necessary to watch the plow constantly to be sure that it was not cutting more dirt than the elevator could properly handle. Recent outstanding developments, however, have reduced this restriction to maximum elevator efficiency.

Previously the power required to plow the earth, to operate the elevator and to pull the grader had to come from the tractor pulling the combination, but present construction offers two alternatives: first, a separate power unit to operate the elevator, and mounted upon the grader frame; second, a device known as the power take-off, which connects with the elevator directly from the drive gears of the tractor pulling the grader.

Many advantages are claimed for each type. For



ELEVATING GRADER DEVELOPMENT IN TRACTOR HAULAGE AND POWER-DRIVEN LOADERS

(1) Elevating grader and crawler wagon unit. (2) Loader drive by power take-off from tractor. (3) Cart type crawler wagon. (4) Loader drive from rear axle. (5) Loader drive from engine on grader. (6) Detail of plow and loader. (7) Four-wheel type of crawler wagon.

the first—namely, the separate elevator motor—the tractor has an increased amount of power available for delivering a larger furrow slice of material to the belt. Many of the difficulties encountered with the older-type grader with rear axle drive, such as slipping of the rear wheel in wet soils, loose soils and sandy soils, are entirely eliminated, and many of the problems of excessive strains on the rear end of the older-type elevating grader are entirely done away with. An elevating grader equipped with separate elevating motor can operate, therefore, in practically any place where the crawler tractor can pull it. The separate elevator motor is capable of accelerating the speed of the elevator to take care of the varying amounts of material supplied by the plow. In other words, the capacity of an elevating grader, equipped with separate elevator power, is limited only by the amount of soil that can be cut with the plow.

Important advantages are justifiably claimed for the power take-off system of elevator control. It offers a combined unit of greater simplicity and less grader weight and the concentration of power in one unit rather than two. Other advantages are a faster moving belt and greater capacity; a constant and uniform belt speed, irrespective of the movement of the grader as a whole; a positive drive, irrespective of the load put upon the elevator by the plow; no clogging and a uniform delivery of dirt, plus the opportunity to work the plow to its full capacity, which greatly increases the capacity of the grader; the ability to work in soils prohibitive to the rear-axle type of elevator drive; a big saving in gasoline and wear and tear on the tractor, by reason of the decreased load it has to pull, and a big saving in repairs to the grader, because of elimination of wear on the drive wheel, short shaft gears and other driving mechanism between the rear wheel and the elevator. An elevating grader thus equipped is freed from troublesome tie-ups and offers extra assurance of continuous operation.

Both the separate-motor and the power-take-off systems of elevator drive, therefore, have their advantages. Where the size of the furrow is limited only by the capacity of the crawler tractor pulling the elevating grader, the engine-driven belt type has more capacity. Where hardness of the soil is such that the weight of the plow limits the furrow slice, the power take-off is superior, because of its simplicity (fewer parts to service) and because a less-experienced elevator operator is required.

In the past, and with the rear-axle type of elevator drive, it was more or less customary to make estimates on the basis of the minimum average of 1,000 cu.yd. per day, but with modern machines, incorporating either the separate elevator motor or power take-off, and with powerful crawler-type tractors, it is the rule rather than the exception that this minimum average of 1,000 cu.yd. per day is considerably exceeded.

Increasing Efficiency and Performance

The tendency in modern elevating-grader construction is to increase the size and capacity of the machines, which is done basically, besides the important innovations described above, by increasing the width of the belt until a 42-in. belt has become largely standard. The tendency is to reduce friction by the use of anti-friction bearings and to make the grader stronger to meet the increased capacity of the tractor pulling it.

Many factors have limited maximum efficiency and productiveness. First, there was wood frame and elevator construction, displaced by steel construction to offer greater strength, and, second, unsatisfactory power available to pull the grader unit. Horses were displaced by steam tractors, steam tractors by gasoline tractors and gasoline tractors of the wheeled type by gasoline tractors of the crawler type. Steam tractors proved too clumsy and hard to turn around, and they required special attention and expense for fuel and water. Third, elevator drive limitations caused the displacement of the rear-wheel drive device by belt from the elevator to the steam engine. This was followed by improved chain devices from a revolving rear axle, and more recently by the special elevator motor and the power take-off. A fourth limiting factor to elevating grader efficiency was friction on the belt and other troublesome experiences with what is commonly known as the pan cleaner unit. Much experimental work was done with this unit, and manufacturers tried different methods, first, a pan-cleaning rod, known as the stoker rod; second, a continuous chain; third, a hand lever type, operated from the operator's platform; and fourth, a continuous-screw, power-driven type, known as the spiral pan cleaner, which has proved vastly superior to all other types.

The limiting factor of capacity has been largely overcome. Whereas a few years ago the maximum capacity of an elevating grader ran from 60,000 to 100,000 cu.yd. per season, the modern elevating grader has been known to handle as much as 40,000 cu.yd. in one month.

Crawler Wagon a Co-ordinate Unit

Some five years ago the first crawler wagon was offered to contractors, and it soon became apparent that the small-type elevating grader would be inadequate to act as a loading medium for such large-capacity wagons. Manufacturers immediately took steps to increase the capacity of the elevating grader. The modern elevating grader is so completely dependent upon the use of this new-type crawler wagon that the two units cannot be treated except together.

A limiting factor of the elevating grader of the past was the horsedrawn wagon. The crawler wagon, however, has changed this shortcoming because of its much larger capacity, and the efficiency and greatly increased productiveness of the combination of modern elevating graders and crawler wagons, plus the large crawler-type tractors to pull them, have thoroughly revolutionized these methods of handling soil.

The crawler-type wagon was developed because the lighter wagons, used in tandem, have never been entirely successful, and the desire was to build a wagon that would follow the crawler tractor in any and all places and conditions of soil. Various types of crawler dump wagons were developed—side dump, end dump and bottom dump. Crawler wagons are designed with a very low center of gravity in order to eliminate the possibility of upsetting and that they may be used successfully with elevating graders. An extremely high wagon requires a considerably longer elevator, which in turn takes up more space. General experience has proved that the bottom-dump type of crawler wagon is preferable to others, because of its greater stability under all embankment conditions and because of its greater simplicity and economy in maintenance.

Two types of crawler wagons have met with approval in the field, one in which the front end is supported by a set of round wheels and the body by crawlers, and the other in which there are no front wheels but a stiff tongue from the body which connects direct with the drawbar of the tractor. There are advantages and disadvantages to both types. Primarily it might be said that the one with round wheels in front has larger capacity and presents no problem of weight on the drawbar of the crawler tractor. The direct hitch type uses the braking power of the tractor to hold back its load on steep grades, and is recommended always where hills and abrupt fills are encountered.

Crawler wagons, in general, are manufactured as complete all-steel units, in which side plates and end plates are made with rolled edges heavily stiffened with angles and fastened with hot rivets. Alloy steel parts are used to increase strength without increasing weight. Door-control devices are simple in construction, yet most positive and very easy of manipulation.

The fact that crawler wagons, pulled by crawler tractors, can be used over wet places, hilly places, rough fills, etc., has put them in a class remote from the old method of handling dirt by the use of horsedrawn vehicles. Furthermore, it is no problem now to work 24 hours per day, using two or three shifts, thereby more than doubling the capacity of the units, both elevating grader and crawler wagon, getting more than twice the output for the same initial investment.

Special Parts Manufacture Improves Construction Machinery

By Kenneth H. Condit
Editor, American Machinist, New York City

FROM the standpoint of the machinery designer and manufacturer, construction machinery until recently has ranked with textile machinery in being the most backward in incorporating the lessons in design and materials that have been learned in other machinery fields. As in the textile field, this has been the fault of the buyer and user of the machines rather than that of the builder.

Possibly the most important factor in present trends in construction machinery, from the standpoint of the manufacturer, has been the acceptance of standard parts and units that have been so highly developed for other classes of machines. Among these may be mentioned ball and roller bearings, drive units, alloy-steel axles, gears and other parts. The manufacture of such units has long since become highly specialized, so that a high type of design is produced accurately and cheaply on a large-quantity basis. The acceptance of such parts and units for construction machinery has not only given the machines better working parts but has also given their producers the advertising advantage of the known reputation of the special units. And by freeing them of the annoyance of caring for details it has permitted manufacturers to devote their engineering energies to the actual betterment of the larger functions of their machines. The net results are better machines that entail less maintenance and less manual attention and a greater demand for these machines, enabling the manufacturer to put his plant more and more on a continuous production basis.

With the adoption of standardized specialized parts there has also come the specialization of purely construction-machinery parts and units, such as wheels, crawler parts, dippers and shovel teeth. Manufacturers of these parts are able to incorporate specially treated steels and to adopt welding and other manufacturing processes that work in readily in quantity production.

Such parts as dipper teeth and crawler treads, when procured from plants making that class of casting solely, become a very specialized job, and instead of being reduced to a minor detail that might be slighted in the plant of the machinery manufacturer whose engineers are thinking in terms of the larger problems of the machine, they become major problems for the parts and units manufacturer, and as such become highly developed. The latter also, assured of a market for larger quantities than any single machine builder could consume, is able to set up his manufacturing organization for line production, so that actually he furnishes the better parts to the machine builder at a lower price than it would cost the builder to make them himself.

As a special example of what has been done in redesign we can take the rock crusher. By employing the newer high-manganese steel castings the whole frame and size of the machine was reduced. Manganese-alloy steel jaws added long life; alloy-steels in the toggles reduced the size and added life; roller bearings in the working parts reduced lubrication difficulties, minimized noise and vibration, and added life. The user therefore now has a crusher that is more efficient and durable, that takes up less space and is more easily transportable, and the builder has a product much more economical to manufacture.

Acceptance of mechanical refinements by construction engineers has naturally encouraged engineers in the manufacturing plants to study the construction field more closely and to incorporate in the machines refinements that may be classed as esthetic or as "sales appeal." This has not been to the benefit of the manufacturer alone. High-grade paints and finishes already developed for the automotive field have also helped to maintain the machines in good condition in service and to give them a better resale value after a job is finished. Streamlines and the better appearance of standard radiators and other units, also adopted from automotive designs, on the newer road-rollers have done away with any aversion that the town authorities or the public may have had for the older unsightly steam roller. Again the reaction has been a broader market that has still further enabled the machine builder to expand his plant organization along modern lines for economic production.

To sum up, therefore, it may be said that this modern appreciation of the saving of labor and general all-around efficiency of standardized quantity-produced machines by the contractors and their willingness to co-operate freely with the designing engineers have now placed the construction machinery manufacturer in as opportune a position as the automobile builder or the machine-tool manufacturer to organize his factory for quantity production and to deliver more efficient machinery for the same or less money.

Crawler Traction Revolutionizes Equipment Mobility

All Machines Put on Rails

By A. E. Loder
General Supervisor, Construction Sales, Caterpillar Tractor Co., Peoria, Ill.

Some 40 Years Ago there were several well-thought-out designs and models of locomotives having on each side an endless chain of rails, much similar in operation to the tracks or treads of the modern crawler traction. Possibly the idea of the crawler is still older, but it was not until almost twenty years later that the crawler or caterpillar tractor became a demonstrated piece of construction equipment on the Los Angeles aqueduct. Today in all except its general features of crawlers and internal combustion engines the crawler tractor is a different machine and crawler traction has spread to almost every type of equipment that travels on the natural soil. Naturally the crawler traction has its most perfected forms on the modern tractor, because it has here its most severe use, and in this article the tractor crawler is considered primarily. Incidentally it is the firm of manufacturers with which the author of the article is connected that employed the first crawler on a tractor, that built the crawler tractors for the Los Angeles aqueduct work and that has been a principal in perfecting the improvements which have made crawler traction an almost universal mounting for heavy mobile construction equipment. —Editor.

CRAWLER traction has been one of the greatest contributions of all times to the machinery of construction. It has given the constructor mobile and effective power units and has brought with it a long list of the most effective construction equipment the world has ever known.

The wheel, man's greatest invention of early times, requires a hard surface on which to roll; otherwise the waste of power becomes excessive and modern power units cannot be moved into effective action. Crawler traction has lifted the wheel out of the mud and power-wasting soft ground, and has put it on self-laying steel rails, where it rolls with positive traction and low frictional resistance and where its load may be widely spread.

The man-powered wheelbarrows of the early canal and railroad building days gave way to horsedrawn scrapers and wagons as man power became too expensive. Later, steam shovels operated on steel rails came into railroad construction work, but their field was limited by the expense of moving track and the construction of pioneer roads, trestles and bridges to carry the heavy shovel units.

The requirement for mobile equipment which could be handled in all kinds of rough or soft going over new construction work and into difficult locations generally limited the contractor's outfit to light horsedrawn units, which in those days could be operated with a comparatively low labor cost and small costs for animals and feed as compared with conditions of today. The engineer also curved the early railroads around the hills where the work was easiest and the quantities small.

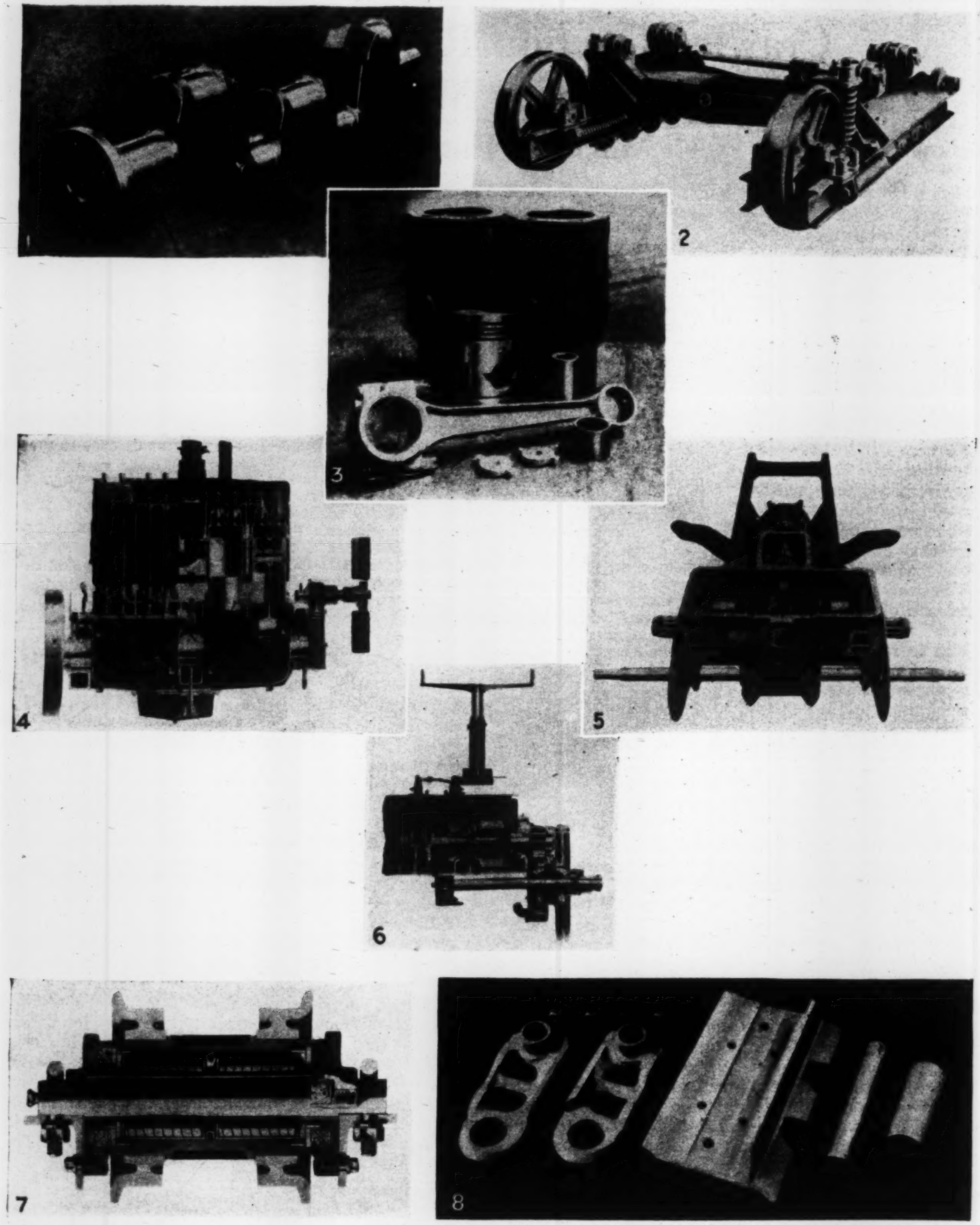
Then came the early elevating graders, which showed the need for the greater horsepower and larger wagons. About this time attempts were made to use wheel-type steam traction engines to pull construction equipment, and wheel-traction units were used under steam shovels. The traction wheels in both cases proved inefficient. They were lacking in tractive and supporting power over soft ground, while the rolling resistance was excessive. With much expense, blacksmithing and persuasion, the heavy wheel units could be operated over well-prepared roadways when the weather was good, but after a rain the job was tied up for an expensive period. Contractors soon turned back to their mules and labor camps. In the meantime the cost of labor and mule operation climbed steadily higher, while the demand for higher standards increased the quantities of material to be handled.

California ranchers had been going through similar experiences in their attempts to cultivate and harvest over soft, reclaimed lands and peat beds in the lower Sacramento and San Joaquin river valleys, where it was sometimes almost impossible for horses to travel. The climax had been reached when a three-wheel tractor built by the Holt Manufacturing Co. about 1898 was provided with two main driving wheels, each of which had a diameter of 8 ft. and an extended tire width of 18 ft., giving 36 ft. of wheel width for the driving units. This was probably the largest and most powerful traction engine ever built. It emphasized the fact that weight increased in proportion to the width of wheels, proving that little could be gained along this line.

In the early part of 1900 Benjamin Holt built a pair of tracks, or platform wheels as they were first called, and installed them on a steam tractor. It was a crude arrangement, but worked so well that a better one was immediately built. It was found that a small 40-hp. steam tractor mounted on track-type tracks would pull more load than a 60-hp. wheel-type steamer. It pulled one-third more plows and all to a 2-in. greater depth than the 60-hp. wheel machine. This marked the beginning of a new era in mobile power. From this time on the development of track-type tractors by both Benjamin Holt and C. L. Best progressed rapidly. The many years' experience of these men in building and servicing heavy steam wheel tractors was brought to bear on the improvement of this new type of machine. In 1905 gasoline engines replaced the steam units, reducing the weight to reasonable limits.

First Construction Use on the Los Angeles Aqueduct

The first notable application of these machines to construction was in 1908, when a fleet of early model caterpillar tractors was put to work on the Los Angeles



CRAWLER TRACTION AND MODERN TRACTOR DETAILS

(1) Single forging tractor crankshaft. (2) Crawler track roller frame. (3) Tractor piston details. (4) Section of 60-hp. tractor engine. (5) Tractor transmission. (6) Tractor steering mechanism. (7) Track roller details. (8) Standard crawler parts.

aqueduct, hauling construction materials across the Mojave Desert, where they traveled over beds of loose sand and up steep, roadless mountain grades to the line of construction.

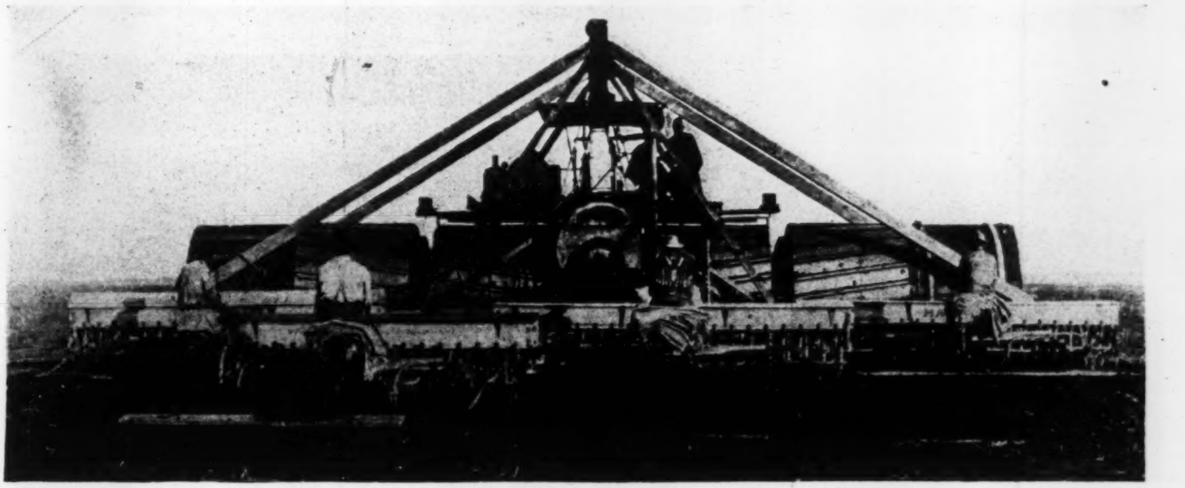
These early machines were crude affairs compared with those of today, but they showed the possibilities of crawler traction in furnishing mobile traction units and carrying heavy machines over soft ground into previously inaccessible locations.

These first track-type machines were of the three-wheel type, with two relatively short track wheels furnishing traction, and a single front steering wheel. Steering clutches in one form or another were used to declutch the power from the inside track while the outside track and steering wheel gradually swung the machine around. On the heaviest pulls the weight on the front steering wheel decreased, making it difficult to turn under load. A lot of room was required for turning, which limited the machine on construction work.

A study of these problems brought about the development of the present form of track-type tractor, first known as the "muley" type. In it the troublesome front steering wheel is eliminated. The motor and driving mechanism are carried on a pair of relatively long track wheels which propel the machine. Steering is accomplished by steering clutches and steering brakes. The track on the inside of the turn is declutched and the entire available power applied to the outer track, driving the machine around the curve and pulling its load. The use of steering brakes in addition to steering clutches makes it possible to apply braking resistance to the declutched track on the inside of the turn in any desired degree. By this means it is possible accurately to control the degree or sharpness of turn. Increasing the pressure on the brake sharpens the turn. By pressing the steering brake until the track becomes stationary, it is possible to turn a tractor of this type to a sharp right-angle turn, or if desired, it can be continued around in its own tracks until it will face directly to the rear.

To protect the steering clutches from undue wear and save power, it is best to employ a steering system in which the track is completely declutched before applying the steering brake. In a few cases a modified form of differential is utilized to provide for turning when steering brakes are applied against the power on the side toward which it is desired to turn. This causes the machine to turn in a curve but does not facilitate right-angle turns or sharp face-about turns.

The business end of a track-type tractor is its tracks and track-driving mechanism. The weight and driving reactions of the engine and gear system are carried on a pair of heavy truck frames so constructed as to oscillate independently about a rear axle or pivot shaft. Oscillation of the truck frames is provided for by a heavy equalizer spring or bar, crossing under the forward portions of the two truck frames. In view of the tremendous lateral strains on the truck frames when turning or traveling along steep side hills, it is necessary that they be heavily braced to the pivot shaft or axis of oscillation. This is an important feature to be considered when selecting crawler traction equipment.



ORIGINAL HOLT TRACTOR, WITH 36-FT. TIRE SPREAD, BUILT IN 1898

The truck frames are carried on a series of truck rollers which travel on the endless rails of the track system. In the forward end of the truck frame a heavy front idler serves to support the top line of the endless track as it is being carried forward and laid on the ground. It also serves to support a portion of the weight on the truck frame when in soft ground.

In the rear portion of the truck frame is the driving sprocket, which engages positively with the bushings of the track links and through which the power of the engine drives the track roller system ahead over the endless rails of the track. The sprocket is so placed that it supports load only when in soft ground. The endless track on which the machine travels consists of a pair of rail-shaped links which support the truck rollers and serve to transmit their load into the track shoes, which in turn distribute it over a large ground area.

Smooth travel over irregular ground is provided in part by oscillation in the truck frames and in part by the fact that the series of truck rollers is held in a straight line by the truck roller frame. This in turn causes the lower track rails to maintain a comparatively straight line regardless of inequalities of the ground. The result is that the machine travels ahead over smooth hard steel rails. Positive traction, equaling that of a cog railroad, is secured by the sprockets reacting against the track bushings, while the grousers of the track shoes in turn react against the ground to prevent slippage.

The track sprocket, truck rollers and front idler of a

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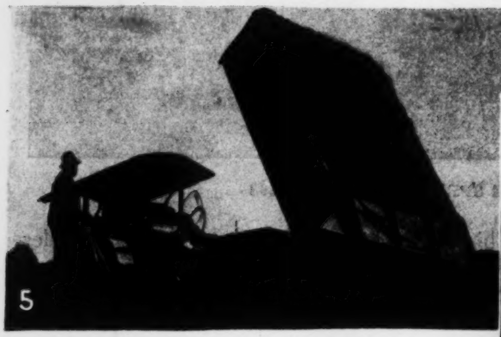

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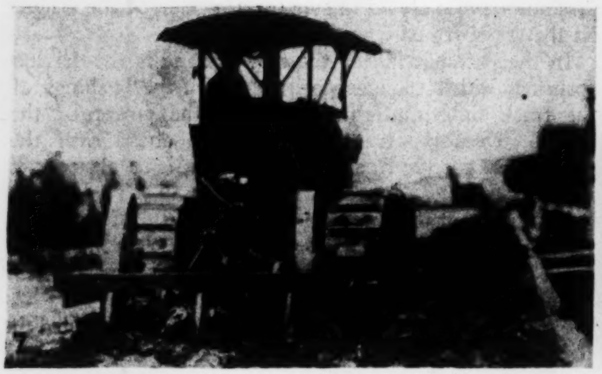

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TYPICAL APPLICATIONS OF TRACK-TYPE TRACTORS IN CONSTRUCTION HAULAGE AND EXCAVATION

(1) Tractor-hauled elevating grader with power take-off from tractor. (2) Tractor-hauled dump wagon and elevating grader outfit. (3) Tractor excavator with wheeled scrapers in train. (4) Tractors operating scrapers with hydraulic power take-off. (5) Tractor fill with end-dump crawler wagons. (6) Tractor leveling fill with bulldozer. (7) Tractor-operated scarifier. (8) Tractor-operated rooter plow.

track-type tractor are called upon to perform under the most adverse conditions possible to find. They must travel over the roughest kind of ground, causing heavy strains. They must crawl through loose sand or muck; through slimy mud carrying the most destructive abrasive mixtures, which will try the quality of any metal and penetrate to destroy bearings, if they are not guarded with the greatest skill.

Prevailing practice is to use drop forgings for the track rails, which eliminates hidden flaws and makes it possible to secure uniformity with a strong, tough structure and a hard rail surface to carry the rolling load. But even in this it was found that ordinary drop forgings would not serve the purpose. It was necessary for the metallurgists to find new and improved forging methods and standards of quality to get the desired result. This has resulted in more exacting specifications for the track links and other important forged parts of a track-type tractor than are used by the trade for other forging work. The same may be said of the truck rollers which travel on the track rails. These are made by shrinking drop-forged heat-treated treads and flanges on cast hubs.

It was soon discovered that lubrication of the pins and bushings of a track caused it to wear out faster than when run dry. The lubricant collected and held the grit, making it more destructive than when it is free to pass out of the joint. It has required years of study on the part of designing engineers, metallurgists and heat-treating engineers to find the best metals and the best manner in which to treat them, in order to resist abrasion and prolong the life of the tracks. All have been thoroughly tried out under a wide range of heat treating, with the result that the practice in selecting steels and their heat treatment is now sufficiently systematized to permit a user to select his machine with confidence in its performance.

Success of the track-type tractor has brought with it the application of crawler traction in varied forms to serve as mounts and propelling units for a variety of heavy construction equipment such as shovels, cranes, concrete mixers, draglines and practically every type of heavy contractor's equipment which may not be built to run on a railroad track. The fact that the crawler traction units under these specialized machines travel quite slowly, and as a rule only a portion of the time, makes it possible to build them in a simpler manner and of less expensive materials than is the case with the track-type tractor, where continuous travel must be had at a much higher speed than is required by the other machines.

Special Truck for Survey Parties

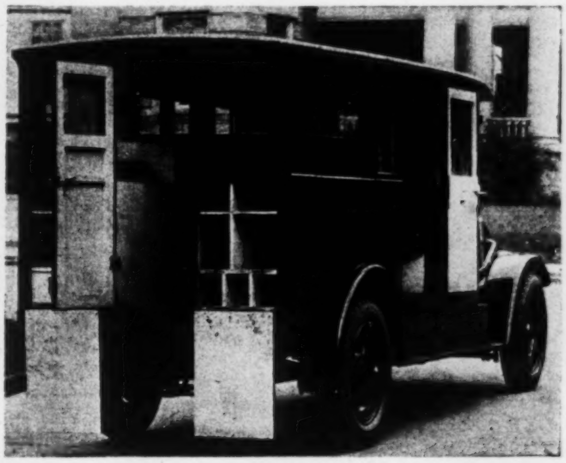
By Walter Starkweather
Engineer of Surveys, Detroit, Mich.

A NEW type of field engineers' truck has been developed and designed by the bureau of surveys of the city engineer's office of Detroit, and twelve of the oldest of its fleet of 32 survey trucks have just been replaced with the new model. The custom-made body is designed to carry comfortably a field party of six men, surveying instruments, stakes and the rest of the field equipment and tools.

The space behind the driver's seat is 9 ft. 4 in. long and 5 ft. 5 in. wide outside, and contains a compartment for four men. This compartment occupies the whole width of the truck and is fitted with side doors; access to the rear door of the truck is given by an 18-in. aisle. Sufficient room has been provided in the compartment to enable those engaged in sewer tunnel construction work to change their clothes en route. The framework and floor of the truck are of clear, kiln-dried oak, and the seat frames, inside partitions and compartments are of clear whitewood. The interior is painted a light gray. The outside of the body is covered with 20-gage sheet steel.

The space behind the men's compartment, on either side of the aisle, contains built-in boxes for engineer's transit and wye-level, a general utility box for saw, carpenter's level and similar tools, a drawer for steel tapes, plumb bobs, surveying pins and other small special equipment, and a map and plan pocket. The boxes for the instruments are fitted with small springs on the sides and top to hold the instrument cases firmly and soft rubber pads on the bottoms of the boxes to absorb shock. There is space for the jack and tire tools under the driver's seat, for rubber boots under the other seats, and there is a rack for field books in the front of the car, just over the windshield.

The outside compartments at the rear of the truck have space for more than 300 stakes of different sizes, two 7-ft. level rods, two ranging poles, two tripods and a drawer for small tools. These compartments are closed by wooden flaps, hinged at the bottom. On each running board, under the edge of the body, is a box 6 ft. 3 in. long. In one box are kept the large tools, including picks, long-handled shovels, sledges, frost bars and brush hooks, and in the other 6-ft. pine sight strips. Seven padlocks will secure all exterior compartment boxes and the spare tire, carried in a rack under the rear of the truck.



SPECIAL TRUCK BODY FOR SURVEY PARTIES

There are other special features which add to safety and convenience, such as non-shatterable wire glass in the men's compartment and the equipment section, electric windshield wiper, two dome lights operated from the dash, three green highway lights front and rear, and a 5-gal. drinking water tank in a small compartment on the right side. On the left side there is a small compartment which may be used for additional 18-in. stakes or for special equipment like electric hand drill, gas masks or first-aid kit.

News of the Week

Formulate Model Lien Law

Unanimous agreement on a draft for a proposed uniform lien act to be submitted to the several states for enactment has been reached by the standard state mechanics' lien act committee of the U. S. Department of Commerce, appointed in 1924 by Herbert Hoover, then Secretary of Commerce. The proposed act will be submitted to the Conference of Commissioners on Uniform Laws, representing the bar associations of the several states, for approval before being presented to the state legislatures as a measure to replace existing statutes.

Cleveland Planning Water System for Regional Area

A commission of three engineers consisting of Robert Hoffman, city engineer; James H. Herron, Cleveland, and L. R. Howson, Chicago, consulting engineers, has been appointed to report on and check over a $60,000,000 water-supply development for Cleveland, Ohio, which supplies water to most of the outside territory in Cuyahoga County and to some additional municipalities. The proposed program involves the construction of a third intake in Lake Erie, 5 miles out, having a capacity of 300 m.g.d., a 200-m.g.d. pumping station, 200-m.g.d. filter plant, a number of large distributing reservoirs and a large mileage of big feeder mains. These matters refer to recommendations made by L. A. Quale, chief engineer, department of public utilities. The engineering commission is to report by May 1 of this year.

Olean Paying $425,000 Damage for 1928 Typhoid Outbreak

Damages paid on account of the water-borne typhoid outbreak at Olean, N. Y., in 1928, have exhausted a $350,000 bond issue and the city authorities are seeking authority from the legislature to issue $75,000 more. According to *Health News* (official bulletin of the State Department of Health) for March 31: "In assuming complete liability for the epidemic the city has held itself responsible for all medical and nursing care, and loss of time and life as a result of 212 cases and at least eighteen deaths."

The outbreak was traced by the department just named to a leaky submerged suction main from emergency wells on one side of the Allegheny River to a pumping station on the other side. In a report on the outbreak the department stated that had daily tests for excess chlorine been made the pollution would have been shown. The local officials failed to notify the department of a sudden outburst of diarrhea that preceded the typhoid epidemic. (See *Engineering News-Record*, Oct. 18, 1928, p. 600, and Jan. 3, 1929, p. 39, for further particulars.)

Public Building Bill Signed

President Hoover on March 31 signed the Elliott-Keyes bill appropriating $230,000,000 for the construction of public buildings throughout the country during the next ten years. Of this amount, $115,000,000 will be used in the District of Columbia. Addition of this sum to money previously appropriated and not yet expended means that the federal building program during the next decade should approximate $50,000,000 annually, according to a statement made by Representative Elliott, sponsor of the bill.

Zoning Ordinance Held Invalid

A zoning ordinance creating a residential district has been held unconstitutional by the Supreme Court of Pennsylvania as it affects an unimproved lot worth, for residential purposes, between $12,000 and $20,000, and, for business purposes, between $90,000 and $100,000, on the ground that the ordinance is confiscatory as regards the lot in question. The tract of land concerned, situated at the intersection of two busy streets in Llanerch, Pa., a suburb of Philadelphia, is triangular in shape and has always been undeveloped and vacant land. Testimony brought out that land immediately opposite the lot in question was used for business purposes, that utilization of the lot for residential purposes would leave 86 per cent of its area entirely vacant, and that, although the value of the land for residential use was only from $12,000 to $20,000, an offer of $90,000 had been made the owner for business purposes.

The court held that, although reduction in value shared by most owners in a locality because of a general scheme of zoning is not in itself enough to render the ordinance confiscatory, as a general rule in zoning territory the line should be fixed in such a way as to avoid making one side of a street purely residential with the opposite side already in use for business purposes to such an extent as to have established its character in that regard.

Large British Bridge Proposed

Construction of a $10,000,000 bridge across the River Humber, in England, connecting the counties of Yorkshire and Lincolnshire at Hull, is favored in a report on the project submitted by Sir Douglas Fox & Partners, consulting engineers, who have investigated the relative advantages of a bridge and a tunnel. The structure would be of the high-level type with a total length of 3¼ miles and a maximum span of 900 ft. Time required for construction is set at five years. The estimated cost of $10,000,000 is for a highway bridge only; provision for railway tracks would increase this to approximately $20,000,000.

Greater Pittsburgh Plan Must Await Further Legislation

A second referendum vote on the Pittsburgh metropolitan charter plan, defeated June 25, 1929, cannot be had under existing legislation, according to a decision of the Pennsylvania Supreme Court, affirming the decision of the lower court. One of the objects of the plan was to put Pittsburgh well toward the head of the cities of the country in population rank by the U. S. Census of 1930. The next state legislature will be asked to authorize resubmission of the plan to the electorate of Allegheny County in November, 1931. The plan was approved by more than the required two-thirds majority of total votes cast but was thirteen municipalities short of the necessary two-thirds of the 122 municipalities in Allegheny County.

Bids to Be Invited on Private Incinerator at San Francisco

After long delays over the problem of garbage disposal, the board of supervisors of San Francisco on March 17 voted $10,000 to be expended by the city engineer for test borings, plans and specifications relative to a new incinerator with a capacity of 750 tons per day which the city is desirous of building on a 200x400-ft. lot close to the old destructor now in service.

When the foundation studies are finished and specifications of a preliminary, general nature are ready the board will, according to the resolution, "authorize the receipt of bids for the construction of a plant privately built in conformity with such plans and specifications with the understanding that all bids submitted shall contain a recapture clause under which the city may take over the plant after a term of years." It is reported that unless bought by the city previously, the incinerator would become the property of the city, without payment, at the end of 25 years.

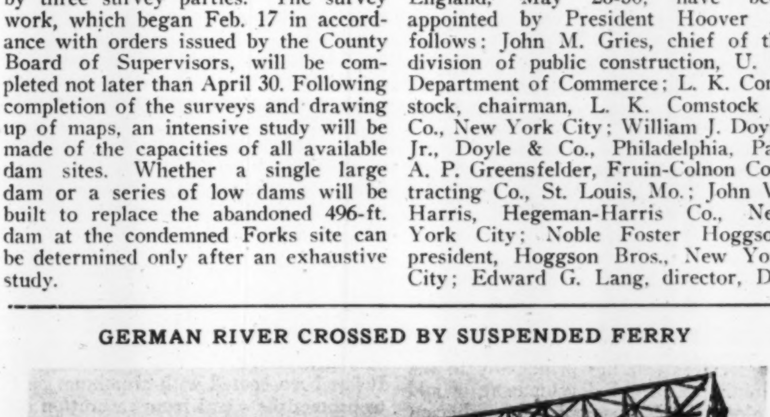
This plan was thought to be necessary because the new plant, estimated to cost about $1,000,000, cannot be financed by direct taxation without unduly raising the tax rate, and the bond issue plan was not considered practicable because of the improbability of getting the necessary two-thirds vote.

The invitation for a construction and operation bid does not appear particularly attractive to private interests because, under the initiative ordinance adopted by the voters June 14, 1927, the maximum price that the city can pay for incineration is $1 per ton, and under that limitation the city was, and still is, giving the use of its old incinerator free of charge.

Study San Gabriel Flood Control

Survey of the San Gabriel Canyon watershed in southern California for the purpose of finding a series of dam sites to replace the condemned Forks site abandoned last fall as a location for the proposed $25,000,000 San Gabriel flood-control dam is now 40 per cent completed, according to E. C. Eaton, chief county flood-control engineer. Twelve sites have been tentatively selected and are being inspected by three survey parties. The survey work, which began Feb. 17 in accordance with orders issued by the County Board of Supervisors, will be completed not later than April 30. Following completion of the surveys and drawing up of maps, an intensive study will be made of the capacities of all available dam sites. Whether a single large dam or a series of low dams will be built to replace the abandoned 496-ft. dam at the condemned Forks site can be determined only after an exhaustive study.

GERMAN RIVER CROSSED BY SUSPENDED FERRY



Wide World Photo

Steel framework 108 ft. high supports the car of this aerial ferry over the River Oste between the towns of Basebeck and Osten, Germany. Operation is by electricity. The only structure of this kind in the United States, at Duluth, Minn., has recently been converted into a lift bridge.

Winnipeg Wants Connection With Hudson Bay Railroad

For the purpose of surveying and exploring territory to the east of Lake Winnipeg for a possible direct rail connection with the Hudson Bay Railroad, the city of Winnipeg will advance $30,000 to the provincial government of Manitoba to aid in exploratory work. This action was decided upon three days after the publication of a report made by engineers of the Canadian National Railways, regarding four proposed cutoffs shortening the existing Canadian National route west of Lake Winnipegosis. The estimated cost of the four lines surveyed, which would save from 48 to 173 miles in distance, varies from $2,775,000 to $9,030,000. A charter for a direct route east of Lake Winnipeg, involving an entirely new line, was granted last year to the Emerson-Churchill Colonization Railway Co. by the Manitoba Legislature. This line would extend from Emerson, on the United States boundary, to Churchill, on Hudson Bay, a distance of approximately 775 miles.

Appoint American Delegates to Public Works Congress

American delegates to the fifth International Congress of Building and Public Works, to be held in London, England, May 26-30, have been appointed by President Hoover as follows: John M. Gries, chief of the division of public construction, U. S. Department of Commerce; L. K. Comstock, chairman, L. K. Comstock & Co., New York City; William J. Doyle, Jr., Doyle & Co., Philadelphia, Pa.; A. P. Greensfelder, Fruin-Colnon Contracting Co., St. Louis, Mo.; John W. Harris, Hegeman-Harris Co., New York City; Noble Foster Hoggson, president, Hoggson Bros., New York City; Edward G. Lang, director, Department of Public Works, Pittsburgh, Pa.; Michael J. McDonough, president, building trades department, American Federation of Labor; Gerhardt F. Meyne, contractor, Chicago, Ill.; Truman S. Morgan, American vice-president, International Federation of Building and Public Works, and president, F. W. Dodge Corp., New York City; David T. Riffle, president, National Association of Building Trades Employees; E. A. Simmons, president, Simmons-Boardman Publishing Co., New York City; William A. Starrett, Starrett Bros. Co., New York City; and George B. Walbridge, president, Walbridge-Aldinger Co., Detroit, Mich.

This congress has been organized by the National Federation of Building Trades Employers and the Federation of Civil Engineering Contractors of Great Britain under the patronage of the British government. The proposed agenda will include the following subjects: (1) unification of the principal conditions of contract imposed upon the contractor by public authorities or other proprietors; (2) rationalization as applicable to building and constructional work; (3) scientific research—its utility and application to the industry; (4) education and training for employers in the building or contracting business; (5) capital investment in housing construction for the middle class; (6) the workmen's housing question; (7) apprenticeship.

Indiana Water Works Section Meets at Purdue

Public relations, purification, well supplies and meter reading were the principal subjects of attention at the 23d annual meeting of the Indiana section, American Water Works Association, held at Purdue University, Lafayette, Ind., on March 20 and 21. Of additional interest were the papers and discussions of the sanitary aspects of wells and well supplies.

The importance of the meter reader in maintaining the good will of the consumer was emphasized in two papers. John A. Bruhn, of the Indianapolis Water Co., called attention to the fact that nearly all the contact between consumer and company is through the man that reads the meter and that a proper personnel for this task is highly important. In a paper entitled "Efficiency in Meter Reading," L. D. Shively, chief meter reader of the Indianapolis Water Co., stressed the personal characteristics essential for a satisfactory meter reader. The men in his department are required to be courteous and obliging at all times, even though irksome tasks are frequently called for.

A paper by William C. Groeniger, chairman of research committee, American Society of Sanitary Engineers, called attention to the danger of siphon action in certain types of plumbing fixtures in returning soiled water to the distribution system.

In the Marion (Ind.) iron removal and softening plant, described by Charles

P. Hoover, the existing settling basins are utilized for the treatment processes. The groundwater supply is aerated, clarified and carbonated, but not filtered. The 9-ft. difference in elevation between the two basins, however, can be used in the future as available head for a filter installation.

Frequent sources of pollution of drilled wells were described by C. W. Klassen, of the Illinois State Board of Health. Even where the site selected is such that surface pollution is avoided, it is possible for unsafe water to flow through pervious strata and enter the bottom of a casing if it is not sealed off properly in an impervious layer. To prevent oil wastes from pumping equipment entering the well, the space between the casing and the drop pipe should be closed by a lead seal. A. G. Fiedler, of the U. S. Geological Survey, described several methods of grouting the space between the casing and surrounding material.

W. C. Ridgeway, of Lebanon, was elected chairman of the section for the ensuing year. Other officers selected were: L. S. Finch, Indianapolis, vice-chairman; C. K. Calvert, Indianapolis, secretary-treasurer; H. S. Morse, general manager, Indianapolis Water Co., director of the national organization. The well drillers of the state met jointly with the Indiana section, and formed an organization of their own similar to that recently formed in Illinois.

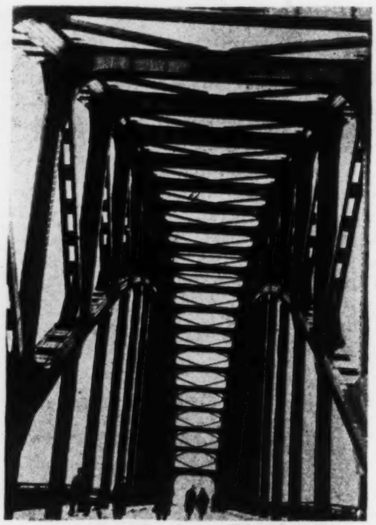
Building Survey Conference Reports Favorable Progress

Heartening results of the efforts of the National Building Survey Conference were reported at its second meeting, held March 27 in Chicago, by Julius Barnes, president of the U. S. Chamber of Commerce, and Fenton B. Turch, Jr., president of the conference. Money is now flowing back in greater volume than ever into savings banks and a sum of $200,000,000 has just been withdrawn by inland bankers from the New York call market. Promotion of modernization and repair work, the immediate effort of the first conference Jan. 21, has resulted in an increase this February of 71 per cent over that for February of last year.

A real effort is being made in the building industry to work out home building on a production basis and to bring the cost within the reach of the 84 per cent of workers whose annual income is below $2,000. Houses of $8,000 and up must be reduced by one-half if this great lower class is to be reached. This was the burden of a paper by L. H. Reume, president of the National Association of Real Estate Boards. In 1921, of all dwellings built, only 24 per cent were multiple units, while in 1928 the proportion had risen to more than 50 per cent. Mr. Reume also stressed the trends to more economical and better use of land subdivision. The old narrow lot of 200-ft. depth is being replaced by a more nearly square lot with a garage adjacent to the house replacing the old stable at the rear.

Earnest A. Hall, president of the U. S. League of Building and Loan Associations, indicated that the associations, which loaned $1,850,000,000 to 500,000 people in 1929, are now in a position to loan even greater sums.

BRIDGE DESIGN IN HOLLAND



Wide World Photo

An unusual pattern is formed by the massive members of this modern highway bridge in Amsterdam, Holland, which shows interesting details of European practice.

Minneapolis Plans to Develop Two Civic Centers

Proposed improvements leading to the construction of two civic centers in different parts of the city of Minneapolis, Minn., are now being studied by the City Planning Commission. The first of these, to be a center of utility and services relating principally to the adjoining railroad development, would be along the Mississippi River adjacent to the present Great Northern Railway station and the proposed post office building. Tentative plans suggest the development of a union passenger terminal at the present Great Northern station, with a taxicab terminal adjoining. Near by would be the new post office, facing a block of land which would be developed as a public square and surrounded by other buildings, such as a joint fire and police station, a municipal court unit and a federal office building. A central exposition building to display commercial and industrial products of the city has also been suggested.

The city has also under way a civic center development of the administrative and esthetic type at the opposite side of the business district adjoining the present auditorium and art museum.

Welding Society Plans Annual Meeting in New York

At the annual meeting of the American Welding Society, to be held in New York City April 23-25, a number of interesting features have been planned. Among the individual papers listed on the tentative program are the following: "Distribution of Stresses in Fillet Welds," by L. C. Bibber, bureau of construction and repair, U. S. Navy; "Investigation of Beams Welded to Columns," by Cyril D. Jensen, Lehigh University; "Battledeck Welded Floor Construction," by Lee H. Miller, American Institute of Steel Construction; "Stiffness of Welded Beam Connections," by C. H. Jennings, Westinghouse Electric & Manufacturing Co., and "The Needs of the Metropolitan District for Instruction in Welding," by R. F. McKay, International Oxygen Co. An architectural session is being arranged covering the subject of welding from the viewpoint of the architect and builder. In addition, the structural steel welding committee of the society will meet, an inspection trip will be made by those attending the convention, and the usual social features have been arranged.

To Test Sprinkler Installations for Airplane Hangars

Tests of the efficacy of various sprinkler systems in an airplane hangar constructed of wood are to be held by the U. S. Bureau of Standards from April 22 to 30 at Washington. Four types of sprinkler are to be tried out: dry pipe, wet pipe and open systems with automatically controlled water supply operated by thermostatic devices in both overhead and overhead-and-floor installations.

A wooden hangar, 65x80 ft., having a clearance of 18 ft. from the floor to the lower chord of the roof trusses, has been built under the supervision of the National Committee on Wood Utilization. The structure differs from the standard hangar in two features only: It has been coated with aluminum paint to protect the wood from saturation due to sprinkler discharge, and a heater and blower system has been installed to dry out the hangar after each test. The floor is of concrete. Water will be supplied by a 55,000-gal. water tank 75 ft. high.

Four types of fires are to be started, under conditions approximating as nearly as possible the usual hangar layout.

The National Board of Fire Underwriters is postponing the promulgation of its code for the construction and protection of airports until the conclusion of the tests. Tentative requirements of the code in regard to automatic sprinklers aroused so much opposition among the industry that the Aeronautics Branch has arranged these practical tests to determine the efficacy of sprinkler systems.

Brief News

Filling the Sacandaga Reservoir started March 27 with the closing of the gates of the Conklingville dam. The reservoir will have an area of 42.3 square miles, a capacity of 224 billion gallons, and an elevation of 771 ft. above sea level. It will supply water to Albany, N. Y.

The Colorado-Kansas Suit over the distribution of Arkansas River waters is to be resumed April 7, probably in Denver, according to announcement by M. C. Hinderlider, Colorado state engineer, and Robert E. Winbourn, attorney-general.

Contract for Clearing 10,000 acres, or 16 square miles, of land in the Lewis River valley behind the dam of the Northwestern Electric Co. at Ariel, Wash., has been awarded to Kelly & Sullivan, of Portland, Ore.

Bricks made of lava from the mountains of Westphalia are being used in the construction of dwellings at Cologne and other cities in Germany. They are relatively cheap and are valued because of their greater insulating properties.

Extensions to Quebec's water-supply system recently authorized include a 30,000,000-gal. reservoir, to cost $1,000,000, and a $400,000 dam on Lake St. Charles to raise the water level 8 ft.

Angora, Turkey, has contracted with two German companies for construction of a $2,500,000 water and sewage-treatment plant.

Steel Erection on the 46-story Waldorf-Astoria Hotel, New York City, was formally started March 24.

The Texas Short Line Railway has been granted permission by the Interstate Commerce Commission to build an 11-mile extension from Grand Saline to Van, Tex., for the purpose of serving the new oilfield in Vanzandt County. Cost of construction is estimated at $370,000.

Civil Service Positions open with the U. S. government, with entrance salaries, include the following: principal hydro-electric engineer, $5,600 to $6,400; senior hydro-electric engineer, $4,600 to $5,200; hydro-electric engineer, $3,800 to $4,400; associate hydro-electric engineer, $3,200 to $3,700; and assistant hydro-electric engineer, $2,600 to $3,100. Applications must be on file with the Civil Service Commission, Washington, D. C., not later than May 7.

Vanderburgh County, Ind., has been ordered by a court decision to pay T. O. Edmond, a contractor, $16,759 for extras on the construction of a road, despite a law specifying that no more than 3 per cent of the contract price shall be allowed for extra claims. Edmond claimed that when the extra work was found necessary, the county commissioners ordered him to proceed and promised that he would be paid. The court held that the county had received full value and that the payment should be allowed.

Everett, Wash., has canceled the contract of the Moran Construction Co., Seattle, for clearing 210 acres of land for the city's $2,000,000 water-supply project and will call for new bids for the work.

The Business Outlook

The week's indicators show only slight if any improvement in contrast to strongly optimistic security markets. Definite recovery in building activity is the bright spot. One uncertain indication of trade conditions is the fact that newspaper advertising lineage for 30 cities in February was the lowest for any month since 1926. Money in the open market was slightly firmer after last week's sharp drop. Commercial paper was a bit easier. There is strong evidence that the ease of funds in the financial centers is gradually spreading out into other regions.

—The Business Week, April 2.

Rubbish Disposal Educational Week at Providence, R. I.

April 7 to 12 is to be a "rubbish disposal educational week" at Providence, R. I., to be followed immediately by a "clean-up week." The public has been invited by Irving Stone, superintendent of the local incinerator department, to visit the incinerator during the first of these two weeks and to search houses and yards for rubbish and put it in the backyards for city collection and incineration the second week.

Judges Appointed for Second Bridge Beauty Award

Appointment of a jury of five members to award prizes for the most artistic bridges built of steel during 1929 has been announced by the American Institute of Steel Construction. The jury consists of two engineers, two architects and a fifth member to represent civic interests. Engineers are Gustav Lindenthal and William H. Burr; architects, Cass Gilbert and Stephen F. Voorhees; the fifth member, Dr. Horace McFarland, president of the Pennsylvania Fine Arts Commission. This year the institute will make two awards: one for the most beautiful steel bridge costing in excess of $200,000, the other for the corresponding structure costing less than that amount. Awards, to be made next June, will be based upon photographs now being received.

Data on Recent Floods in France

Final estimates of the amount of damage caused by heavy floods in the southeastern part of France during the first part of March, as obtained by the U. S. Department of Commerce, indicate that 206 lives were lost, 143,000 hectares (550 square miles) of territory was flooded and 2,693 buildings were destroyed. The total property loss is estimated at more than a billion francs. Damage to mills and factories has put out of their regular employment 3,500 workmen, most of whom are being put to work on repairs and reconstruction. River volume in the affected areas increased from 100 to 132 per cent above normal.

Detailed figures for the various departments affected are given in the following table:

				Rainfall Oct.-Feb., Inclusive		
Department	No. Dead	Buildings Destroyed	Area Flooded (Ha.)	Normal (In.)	Actual (In.)	Ratio
Aude	1	119	24,180	11.0	26.9	2.4
Aveyron	..	16	3,050	14.2	26.1	1.8
Correze	..	0	3,029	11.2	16.2	1.4
Dordogne	..	0	3,191	11.3	21.3	1.9
Gironde	..	38	14,000	....	....	..
Haute Garonne	6	416	600	13.1	18.4	1.4
Herault	..	14	16,025	21.4	46.4	2.2
Lot-et-Garonne	7	91	40,000	9.8	20.8	2.1
Pyrenees Orientales	..	2	2,215	....	....	..
Tarn	6	297	8,500	12.3	21.0	1.7
Tarn-et-Garonne	186	1,700	28,219	8.1	12.1	1.5
Totals	206	2,693	143,009			

A.S.M.E. Celebrates 50 Years of Service

Ceremonies commemorating the 50th anniversary of the founding of the American Society of Mechanical Engineers will be held in New York City, Hoboken, N. J., and Washington, D. C., from April 5 to 9. The first event will be the unveiling of a memorial tablet in the lobby of the Engineering Societies Building in New York City, after which the party will be taken to the offices of the *American Machinist*, where a program will be given depicting the preliminary meeting in 1880 which led to the formation of the society. The auditorium of Stevens Institute at Hoboken, N. J., where the first organization meeting of the society was held, will then be the scene of an anniversary pageant, allegorically depicting the engineer's control over natural forces. During the evening of April 5 the metropolitan section of the society will give a dinner in New York City, at which addresses will be given by Charles M. Piez, president of the A.S.M.E.; James H. McGraw, chairman of the board of the McGraw-Hill Publishing Co., representing the engineering press, and Robert I. Rees, president of the Society for the Promotion of Engineering Education. The final meeting in New York will be a commemorative service to be held Sunday morning, April 6, at the Cathedral of St. John the Divine.

Monday morning, April 7, a welcoming assembly will be held in the National Council Chamber of the U. S.

Chamber of Commerce. Speakers at this meeting will be delegates from foreign countries and representatives of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers and the American Institute of Electrical Engineers. The remainder of the celebration will consist of a reception at the White House, a reception by officers and the council of the society, presentation of medals and the reading of a series of papers by prominent engineers from sixteen geographical divisions of the world on the subject "The Influence of Engineering Upon Civilization."

WASHINGTON NOTES

By Paul Wooton

Washington Correspondent

New Method of Building Levees Studied—War Department Will Reopen Bridge and Pier Cases

An important experiment in levee building is in progress in the New Orleans district. Major-Gen. Lytle Brown, Chief of Engineers, has returned to Washington after a trip down the river, the principal purpose of which was to inspect the work being done by the so-called California dredges. These large dredges are floated in the borrowpit. They have 240-ft. booms and can build levees at a prodigious rate. There is question, however, as to the quality of the work which they do.

It is imperative, General Brown states, that all Mississippi River levees be of the highest quality. His inspection revealed that some of the levees built with these dredges were inferior. This may be due to the fact that their operators were not familiar with the handling of earth of the character found along the river. General Brown was not convinced that the poor work complained of is typical of what may be expected from this new method. At the same time he is not ready to indorse it. He has ordered the most thorough and exacting experiments with the new equipment so as to establish beyond any question whether or not this type of equipment can be used to advantage under conditions such as exist on the lower Mississippi.

Specifications and Costs

While on the river General Brown conferred with contractors as to the specifications under which levees are being built. He found no objection to the specifications themselves, but complaint was made to him that the interpretation of specifications has not been reasonably generous. Having familiarized himself with the contractors' point of view, General Brown will give the matter personal attention in the hope that more liberal interpretations can be made without affecting the grade of the work.

Prices for levee construction seem to increase progressively from New Orleans up the river. Highly satisfactory levee work is being done on that sector of the river at prices averaging around 21c. In the Memphis district the price averages 27c. or higher. Claims are made that this is due to the fact that the territory adjacent to the river in Louisiana and Mississippi is thickly populated. With good roads running along the levees, the problem of getting labor is not a difficult one. In the Memphis region there are fewer good roads adjacent to the levees, and the country near the river is sparsely populated. General Brown is not convinced that this accounts for such a decided spread in prices. This feature of the work is to be studied further.

Congress Approves Federal-Aid Increase

Differences between the federal-aid highway bills passed by the House and the Senate finally were adjusted on April 1 when the Senate agreed to the conference report as detailed last week, p. 541. This report was accepted by the House March 25. Virtually the entire disagreement was caused by the action of the Senate in raising the allowable amount of federal aid from $15,000 to $25,000 per mile. The compromise settlement agreed upon permits the retention of the $25,000 figure, but contains the provision that federal participation shall be limited to $15,000 a mile until the state receiving the aid has completed its original 7 per cent system. Prompt approval of the bill by the President is expected.

Reconsider Bridge and Piers at New York City

The city of New York is going to renew its application for permission to extend the pierhead line 100 ft. riverward at 42d St., it was learned at the War Department on March 31. Commenting upon the situation, the Secretary of War has pointed out that it is important to determine what the fairway or turning distance of vessels would be in terms of feet if the proposed extension of the piers is allowed. Secretary Hurley feels that he understands the situation perfectly after his recent visit to New York.

It is believed that the new proposals to be submitted will contain some provision for alternating pierhead extensions on the New York and New Jersey sides, Secretary Hurley stated. By this method each state would gain in pier length in certain districts without reducing the width of the river channel. Secretary Hurley believes that the interests involved have every reason to co-operate in this connection. The main concern of the War Department is to prevent anything from being done that may develop into a bottleneck obstruction for river traffic, he said.

Regarding the proposed 57th St. bridge at New York City, Secretary Hurley stated that this matter is also open as far as the War Department is concerned. The fact that the Fort Lee bridge, which is farther up the river, will have a clearance of 205 ft. will not necessarily prevent the consideration of a 175-ft. clearance for a bridge at 57th St., he said. There are other matters besides maritime interests to be taken into consideration in connection with the bridge, he pointed out. Relative to this point, he said that appreciation must be given to the enormous expense that would be imposed on the large volume of traffic that would use the bridge if an additional 25 ft. is required in the height.

Mississippi Bridge Heights

An application has been filed with the Chief of Engineers seeking a reduction of 25 ft. in the height of the proposed bridge over the Mississippi River at Twelve Mile Point, just above New Orleans. On instructions from the Secretary of War the case has been reopened. This action followed an appeal to the President and to Secretary Hurley by a New Orleans delegation headed by Mayor Walmsley. In his plea to President Hoover, Mayor Walmsley pointed out that the lower bridge, which would cost $15,000,000, could be financed immediately, thereby contributing something to the relief of unemployment and the revival of business. The President indicated that this assured his sympathetic consideration but that the consent of the Secretary of War first must be obtained.

To Secretary Hurley it was explained that the first permit granted for the bridge, when the late Gen. Harry Taylor was Chief of Engineers, called for a structure 130 ft. above mean Gulf level. When construction did not begin within the period specified, General Jadwin, who had succeeded to the office of Chief of Engineers, required 25 ft. additional height. It was pointed out that steamship interests and others concerned had agreed to the conditions of the first permit. Ralph Modjeski and Frank Masters accompanied the delegation and indorsed the proposed amendments to the present permit.

Illinois Waterway Transfer

Legal questions involved in the proposal to nationalize the Lakes-to-the-Gulf waterway project have been referred to the Department of Justice. One of these questions has been raised by the section in the Constitution of the State of Illinois which prohibits state officials from disposing of public property. Although the Illinois officials are anxious to have the government take over the state's portion of the waterway and complete the work, it would be a difficult and lengthy procedure to obtain official sanction by means of an amendment to the Constitution.

It is now believed, however, that a way out of the difficulty has been found. An examination of similar cases that have arisen in the past has disclosed that the national government summarily took possession of a ship canal at Duluth, Minn., on the ground that it was a necessary part of the navigable waterways system. This action was taken despite the protest of state authorities. After the Department of

Justice has made its recommendations the matter will be sent back to the War Department for final approval before transmission to Congress.

The report of the Illinois district engineers on the practicability of taking over the state's portion of the waterway has not yet been made public. Notwithstanding this, it is generally understood that the report on the project is favorable. It is believed that a diversion of 3,120 sec.-ft. is recommended. This is in excess of the minimum diversion recommended several years hence in the report filed by Special Master Hughes in the diversion case before the Supreme Court.

The court in its decision pointed out, however, that the immediate case concerned diversion for sewage disposal and that water for navigation would be a different matter.

Personal Notes

Ernest B. Hussey, consulting engineer, has been appointed chairman of the Seattle Terminal Board, which has been organized under the City Planning Commission for the purpose of working toward the unification of the railroad freight terminals in that city. J. R. West, chief engineer of the port of Seattle, is also a member of the Seattle Terminal Board.

Admiral **A. Ouchi**, formerly of the Japanese Navy and now managing director of the Mitsubishi Engineering Co., of Tokyo, accompanied by **R. Masaki**, chief engineer of the company, arrived in San Francisco March 21 for a tour of the United States to survey business conditions and openings for new trade channels between the United States and Japan.

Andrew T. Long, rear admiral, U. S. Navy, will retire on April 6, at the statutory age of 64, after 47 years on the active list of the navy. In 1929 President Hoover appointed Admiral Long to represent the United States on the board of directors of the International Hydrographic Bureau.

L. E. Lyon, major, U. S. Army, Corps of Engineers, has been ordered relieved from duty as district engineer at Montgomery, Ala., and appointed corps area engineer, Fourth Corps Area, with headquarters at Fort McPherson, Ga., effective about July 1.

Paul S. Jones, of Sugar Land, Tex., who has recently been employed by the Brazos Valley Irrigation Co., has been appointed associate engineer in the United States Engineer office, Sacramento, Calif. Prior to this he was connected with irrigation development in Arizona and the Palo Verde and Imperial valleys of California.

Charles E. Thornton, Bronxville, N. Y., has been appointed senior assistant utilities engineer for the Maryland Public Service Commission, with headquarters in Baltimore. He fills a vacancy caused by the resignation of Edgar R. Shepperd, who left to become connected with the Bureau of Standards. Mr. Thornton was graduated from the Massachusetts Institute of Technology in 1921 and has been engaged in designing hydro-electric developments in Pennsylvania.

E. A. Cleveland, chief commissioner of the Greater Vancouver Water District, has been authorized by the Vancouver city council to conduct the Cheakamus watershed survey recently authorized at a cost of $25,000 by the taxpayers. The city is investigating this power source on which it holds water rights with a view to deciding whether it will go ahead with the projected municipal power development.

H. J. Spelman has been appointed chief engineer of the West Virginia state road department.

Society Calendar

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; annual meeting, Atlantic City, N. J., June 23-27.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Sacramento, Calif., April 23-24.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, St. Louis, Mo., June 2-6.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 23-25.

INTERNATIONAL CONGRESS OF BUILDING AND PUBLIC WORKS, London; fifth congress, London, England, May 26-30.

INTERNATIONAL RAILWAY CONGRESS, Madrid, Spain, May 5-15. American vice-president, T. S. Morgan, 119 West 42d St., New York.

WORLD POWER CONFERENCE, second plenary meeting, Berlin, Germany, June 16-25. American secretary, O. C. Merrill, Washington, D. C.

AMERICAN INSTITUTE OF QUANTITY SURVEYORS will hold its fifth annual meeting April 14-16 at St. Louis. F. E. Dishner, Detroit, is secretary.

CORPORATION OF PROFESSIONAL ENGINEERS OF QUEBEC held its annual meeting at Montreal March 27. The principal topic of discussion was the granting of temporary licenses to engineers residing outside of the province. Officers elected were: president, A. R. Decary; vice-president, J. M. Robertson; secretary-treasurer, Frederick B. Brown.

FLORIDA ENGINEERING SOCIETY will hold its annual meeting April 17-19 at Ocala. P. L. Reed, Gainesville, is secretary.

FLORIDA SECTION, American Water Works Association, the Florida State Board of Health and the University of Florida are sponsoring a four-day short course in water purification and sewage treatment to be held April 8-11 at Gainesville.

ILLINOIS SECTION, American Water Works Association, will hold its annual meeting at the Stevens Hotel, Chicago, April 23-24. J. J. Doland, Urbana, is secretary.

IOWA ANNUAL WATER WORKS CONFERENCE will be held April 9, 10 and 11 at the University of Iowa, Iowa City. Water surveys, superintendents' problems and responsibilities, maintenance of elevated tanks and pumps, softening, rates and treatment are some the subjects scheduled. Prof. Earle L. Waterman, Iowa City, is handling the conference.

NATIONAL ASSOCIATION OF RAILROAD TIE PRODUCERS will hold its twelfth annual meeting at Memphis, Tenn., on April 29 to May 1. Papers on ties and timber treatment by railroad engineers and representatives of the lumber industry are on the program. Roy M. Edmonds, St. Louis, is secretary.

NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS will organize a new local chapter at Watertown at a meeting to be held April 18. Pending organization, William T. Field is acting as temporary chairman and J. Franklin Larney as temporary secretary.

PACIFIC NORTHWEST SECTION, American Water Works Association, will meet April 24-26 at Portland, Ore.

SOUTHEASTERN SECTION, American Water Works Association, will hold its annual meeting April 15-17 at Savannah, Ga. F. W. Chapman is secretary.

Obituary

James J. Smith, for 25 years city engineer for the city of Grand Forks, N. D., died March 6 in that city. Born in Canada in 1864, Mr. Smith designed all the important sewers in Grand Forks. He had also done considerable engineering work in Denver, Col., and in Reno, Nev.

Frank Larson, 59 years old, for the last 22 years president of the Larson & Danielson Construction Co., of Laporte, Ind., died recently at his home. He was born in Sweden and had lived in the United States 42 years.

John P. Davis, a civil engineer of St. Louis, Mo., died in University City, Mo., on March 23 following a heart attack. He was a highway construction engineer for Missouri at the time the state highway department was organized in 1917. He was 48 years old.

Drexel Lacey, an engineer with the Colorado highway department since 1919, died in Los Angeles, Calif., on March 19, at the age of 37 years. Mr. Lacey had charge of the location work of a large part of the Mount Evans scenic highway.

Reuel E. Anderson, chief draftsman of the U. S. Bureau of Public Roads, located in Denver, died on March 18. He had been connected with the bureau for seven years and was a member of the board of directors of the Colorado Society of Engineers. He was 37 years old.

John Hastie, president of the Sound Construction & Engineering Co., of Seattle, died in Los Angeles on March 17. Mr. Hastie founded the construction company in Seattle in 1910. He was born in western Ontario in 1863 and entered the contracting business in 1886. He constructed many of the large buildings in the Pacific Northwest, including the State Capitol Building at Olympia, Wash.

William Benedict Bull, honorary member of the American Water Works Association and father of several rapid sand filter processes, died on March 25, in Quincy, Ill., the city of his birth in 1844. For many years he was superintendent of the Quincy Water Co., which he and his father owned prior to its sale to the city. His inventions were marketed by the O. H. Jewell Filter Co., with which he was associated in the early days of rapid filter development. His Quincy plant was for years a laboratory for the development of new ideas in filtration.

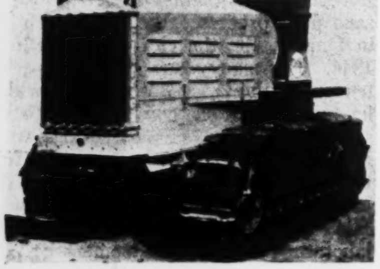
Construction Equipment and Materials

Tractor With Electric Equipment

With a maximum of 80 and a continuous rating of 60 hp. at the drawbar, the new Cletrac 80-60 tractor, recently announced by the Cleveland Tractor Co., Cleveland, Ohio, has many interesting features of design. The machine has a total weight of approximately 10 tons and is equipped with a six-cylinder 5½x6½-in. motor operated at a governed speed of 1,050 r.p.m. The motor itself develops a brake horsepower of 119, with 96 hp. available at the power pulley. General dimensions are: height, 7 ft.; over-all width, 8 ft.; over-all length, 12 ft. 8 in. Ground clearance is 16 in.; turning radius 15 ft. Standard electrical equipment includes a 12-volt Delco-Remy starting, lighting and ignition system, oil cleaner, air cleaner and thermostat regulating engine temperature. Force-feed lubrication supplies oil to all bearings, including wrist pins and valve rocker shafts. The valves are in the head of the motor. Cylinders are of nickel chrome iron, cast in pairs, with pistons of five-ring construction.

Power is transmitted through a Borg & Beck 18-in. pull-type clutch mounted into the engine flywheel. A large flexible joint between the clutch shaft and the upper transmission shaft absorbs noise and vibration and takes care of any small misalignment. The transmission is of the selective type, three speeds forward and one reverse, giving a maximum road speed of 3.6 miles per hour in high gear. An oil pump, mounted at the rear of the transmission case, pumps oil from the final drive gear housing through a filter back into transmission and differential compartment. Final drive from the differential, which is identical in design with other Cletrac models, is through a three-gear planetary gear set mounted in Timken single- and double-row ball bearings. Brake drums for steering are mounted on the drive shaft.

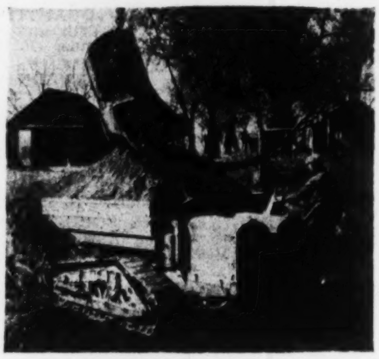
Tracks are 17 in. wide, with a ground length for each track of 75 in. Lubrication of the track mechanism is by means of a central oiling system consisting of a large tank under the hood of the motor, with supply lines running directly down the sides of the transmission case to manifold headers at the top of the track frame. Individual tubes from this header lead to each of the four upper track wheel bearings and the eight lower track wheel bearings.



NEW TRACTOR RATED AT 60 HP.

Transporting and Bulldozing Unit Driven by Twin Motors

Combining in one unit characteristics of truck, tractor and bulldozer, the Koehring Dumptor, announced by the Koehring division of the National Equipment Corp., consists of a steel body mounted on a crawler traction unit driven by two duplicate motors. When in dumping position, the front of the body acts as a bulldozer blade for leveling and grading the dumped material. The body has a level capacity of 5 cu.yd. and a heaped capacity of approximately 6½ cu.yd. It is dumped by means of a hydraulic hoist which elevates the body to an angle of 70 deg. With one sideboard removed, the loading clearance is only 59 in.

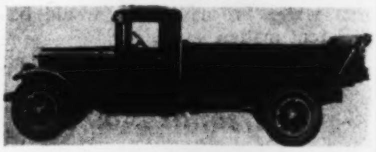


LOADING NEW DIRT-CARRYING UNIT

Power is derived from two International Harvester high-compression valve-in-head gasoline motors with ball-bearing crankshafts and removable cylinder sleeves. Advantages claimed for the twin motors include greater flexibility, faster operation, more power when needed for heavy going, and a positive system of throttle steering without the use of clutches by means of which the operator directs the unit by simply opening or closing the throttle of either motor. The transmission has four speeds forward and one reverse, giving a maximum speed of 5¼ miles per hour. The empty weight of the unit is 18,000 lb.; it has a load capacity of approximately 8 tons. All gears are inclosed, running in oil, and all shafts are mounted on roller bearings. Crawlers have a width of 16 in., and a ground length of 108 in., giving a maximum bearing pressure with an 8-ton load at 9.8 lb. per sq.in. Provision for the comfort of the operator is made by mounting the driving seat on an air-cushioned shock-absorbing pedestal.

New 3-Ton Truck Model

Features of the model A-5 3-ton speed truck recently announced by the International Harvester Co., Chicago, Ill., include a new six-cylinder engine with seven-bearing crankshaft and removable cylinders, single-plate clutch with built-in vibration damper, transmission with five speeds forward and one reverse, mechanical four-wheel brakes and cast-steel spoke-type wheels equipped with pneumatic tires. Force-feed lubrication is employed, a gear-type oil pump, driven from the camshaft, forcing oil under pressure to all main, connecting rod, camshaft and rocker arm bearings. The camshaft is drilled to act as the oil distribution manifold, eliminating the necessity for exterior piping. All lubricants pass through an oil filter. Battery ignition is standard equipment, but high-tension magneto ignition can be substituted if desired. Cooling is by means of a centrifugal water pump attached directly to the cylinder head. The model A-5 is built in four wheelbases—156, 170, 190 and 210 in.



DUMP BODY MOUNTED ON 156-IN. CHASSIS

Welder and Compressor Combined

Many cases arise in welding work in which the preparation of the surface to be welded requires the use of pneumatic tools, such as drills, chipping hammers, wire brushes, sand blasts and other types of compressed air-operated machinery. To provide for such situations, Schramm, Inc., West Chester, Pa., has brought out a series of welder-compressor units driven by a single engine which may be mounted on motor trucks or trailers, or may be used in stationary installations. Units are produced in a number of sizes for various classes of work.

200-AMP. WELDER AND 120-CU.FT. COMPRESSOR, TRUCK MOUNTED

The Business Side of Construction

March Contracts Total Highest of Any Month

FROM Jan. 1 to March 13 each of the eleven weeks of 1930 reported a smaller volume of engineering construction contracts than in 1929. In the week ended March 20, the American Telephone & Telegraph Co. announced construction expenditures by day labor and separate contracts amounting to $106,000,000. This, of course, made a huge total for that week, but even excluding this item, the week was 36 per cent above the corresponding week of 1929. The week of March 27 sustained the volume with an increase of 41 per cent over a year ago. The result for the month was a weekly volume of $98,000,000, the largest on record. The volume index is 408, compared with 382 in March, 1929, and the former record of 395 in May last year.

Except for the quasi-public telephone authorization, the March rise has been in public work. Even including this appropriation, private contracts were 4.5 per cent under the value of those for March, 1929. Public contracts were 63.5 per cent above.

For the first quarter, private work is down 40 per cent, public up 25 per cent. The total change is minus 26 per cent. The decline in private work is general, heaviest throughout the entire West and lightest in the Middle Atlantic states. Also general, with the single exception of the Middle West, is the increase in public work.

The severest drop for the quarter is in buildings, particularly residential and large commercial, 48 and 50 per cent. Industrial building contracts are down 32 per cent, public up 13 per cent. Unclassified private construction is down 20 per cent.

Last year road lettings started slowly, the total for the quarter being only half the value of those of 1928. This year's rate is comparable with that of 1928, when a record was made for the year. The total is $106,000,000, compared with $115,000,000 in 1928 and $60,000,000 in 1929. Figures by months in millions:

	1928	1929	1930
January	27	31	32
February	36	12	29
March	52	17	45
First quarter	115	60	106

Employment Increasing

The census, taking of which starts this month, will supply the only general employment figures having a factual basis. Meanwhile the situation must be gaged by reports of labor unions, government bodies, charitable societies and private institutions. These reports a month ago were more pessimistic than they are now, and the improved outlook appears to be justified by the March increase in contract lettings.

As a measure of conditions in the building trades, of the 848,686 members of that division of the American Federation of Labor, 356,448 were reported idle in March, compared with 364,934 in February. Here there seems to be an improvement even in advance of the construction of the large volume of structures let in March. This volume is 100 per cent greater than for February and 7 per cent greater than for March, 1929. In March, 1929 (an active year), 288,453 members were reported unemployed; in 1928 (the year of record volume), 322,500. This indicates that normal seasonal unemployment is around 35 per cent, and that this year it is 17 per cent below normal.

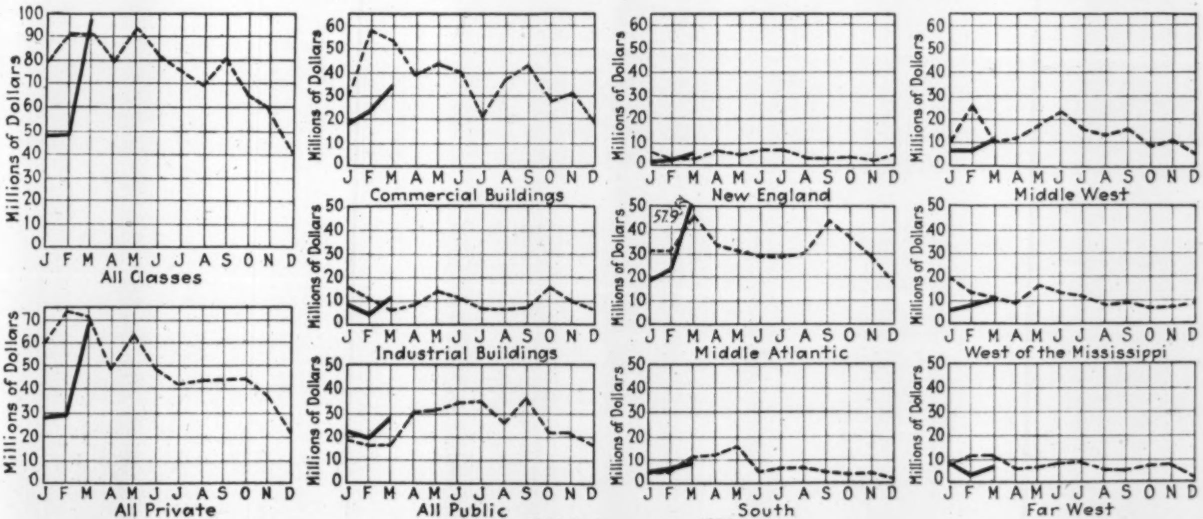
In the absence of general unemployment statistics the New York Board of Trade has selected seven factors for which information was gathered in March from 23 widely distributed cities. Six of the factors were found to be favorable:

1. No further decrease in employment

VALUE OF CONTRACTS AWARDED IN THE UNITED STATES AND TOTAL FOR CANADA, MARCH, 1930

Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States			Canada, March, 1930
							March, 1930	Jan. 1–Apr. 1		
								1930	1929	
Water-works	$30	$2,818	$225	$94	$821	$461	$4,449	$12,107	$10,933	$131
Sewers	81	1,214	402	3,886	806	137	6,526	19,306	17,671	80
Bridges, private	....	2,000	....	45	900	....	2,945	4,420	19,498	....
Bridges, public	54	890	1,198	761	2,717	116	5,736	22,339	14,255	514
Excavations	121	254	429	90	....	107	1,001	6,246	13,653	25
Street and roads	1,899	8,836	8,790	5,267	16,043	4,128	44,963	106,050	60,052	220
Industrial buildings	3,205	12,314	9,855	16,705	2,270	7,077	51,426	106,365	155,256	2,395
Commerical buildings	11,460	67,065	2,111	7,450	10,417	6,300	104,803	261,890	521,102	3,700
Public buildings	2,280	16,087	4,557	5,792	2,069	2,459	33,244	69,722	79,079	4,024
Federal government	293	3,781	3,742	627	431	1,814	10,688	28,249	16,935	....
Unclassified, private	307	110,583	125	210	4,540	1,220	116,985	156,315	188,424	1,022
Unclassified, public	363	5,853	380	352	1,980	139	9,067	33,148	25,084	5,640
March, 1930, 4 weeks	20,093	231,695	31,814	41,279	42,994	23,958	391,833	....	....	17,751
February, 1930, 4 weeks	8,694	63,477	21,366	24,376	30,749	15,423	195,388	....	....	13,170
March, 1929, 4 weeks	14,671	181,316	41,640	40,835	43,805	38,059	360,326	....	....	13,641
Jan. 1–Apr. 1, 1930	36,140	422,985	76,112	99,921	106,199	84,800	....	826,157	....	45,633
Jan. 1–Apr. 1, 1929	54,537	463,980	80,979	197,960	196,150	128,336	....	....	1,121,942	38,995



CONTRACTS AWARDED—AVERAGE WEEK PER MONTH—TOTAL U. S. BY CLASSES—ALL CLASSES BY SECTIONS in manufacturing and public utility plants.

2. Slight improvement in retail and department store employment.

3. Sharp decline in applications of the United States Army enlistment offices.

4. Slight decrease in number of applications at shipping agencies for service at sea.

5. No decline in employment of hotel help.

6. Steady gain in ratio of positions to applications at employment agencies.

The unfavorable factor was a 10 per cent decrease in newspaper advertising.

Four strikes and three wage settlements occurred in March, with the net concrete result of an advance of $1 for Chicago painters.

Following are local conditions in the building trades:

Boston—Of 26,000 mechanics, 53 per cent unemployed, compared with 30 per cent a year ago.

Pittsfield—Carpenters ask five-day week and 5½ days' pay ($55); builders threaten open shop.

New York—Open-shop policy by steel contractors ties up three of Starrett Bros.' jobs.

Summit (N. J.)—Electricians demand advance of $2, to $12, and five days.

Jersey City—Small strike of bricklayers and marble workers over use of material prepared by non-union labor.

Newark—Metal workers on jurisdictional strike over installation of windowframes by ironworkers. Unemployment among carpenters severe; 1,500 of 7,000 out.

Pittsburgh—Of 22,000 mechanics, 30 per cent are unemployed, compared with 10 per cent a year ago.

Birmingham—Of 2,500, half are unemployed, as last year.

Cincinnati—Of 9,000 mechanics, 24 per cent out, as last year.

Cleveland—Of 38,000, there are 15 per cent out, as last year. Ironworkers' strike averted by electricians refusing (to keep the peace) 15c. per hour.

Detroit—Of 25,000, there are 32 per cent out, compared with 28 per cent last year.

Chicago—Painters (18,000) received $1 rise March 3. Ironworkers, who had asked 15 per cent advance early in March, have withdrawn the request.

St. Louis—Unemployment worst since 1914, say labor leaders. Of 18,000 mechanics, 50 per cent out, compared with 33 per cent last year. Of the 9,000 employed, many are on part time.

Minneapolis—Of 10,000, there are 70 per cent unemployed, compared with 20 per cent a year ago.

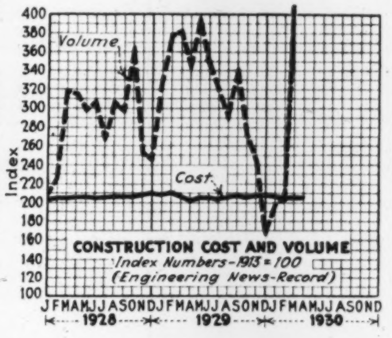
Denver—Unemployment 70 per cent (2,300), compared with 20 per cent a year ago.

Construction Cost and Volume Index Numbers

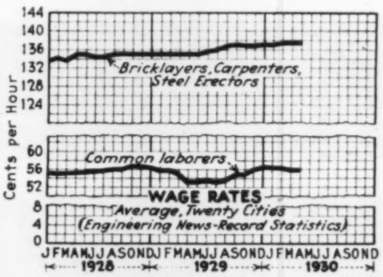
Cost change negligible, slight rise in wages being practically neutralized by drop in lumber price. The Volume Index is twice that for February and is a new record. It is 6.8 per cent more than for March, 1929. Slightly lower lumber prices offset by an increase in the common labor rate, now 56.46c., and 56.15c. on March 1, resulted in a slight change upward (0.32) in the April Cost Index.

E. N.-R. Cost		E. N.-R. Volume*	
Apr., 1930	**207.12**	**Mar., 1930**	**408**
Mar., 1930	206.80	Feb., 1930	204
Apr., 1929	203.40	Mar., 1929	382
Peak, June, 1920	273.80	1929 (average)	317
1929 (average)	207.02	1928 (average)	287
1913 (average)	100.00		
1929		1929	
January	209.40	January	325
February	210.40	February	378
March	207.78	March	382
April	203.40	April	332
May	205.15	May	395
June	205.65	June	347
July	204.77	July	320
August	205.91	August	290
September	207.57	September	340
October	206.32	October	273
November	208.46	November	245
December	209.46	December	166
1930		1930	
January	208.96	January	199
February	206.46	February	204
March	206.80	March	408

*Corrected for price change since 1913.



San Francisco—Union Labor Council reports 50 per cent union building labor unemployed, though only 15 per cent of all classes is out of work. San Francisco Building Department confirms this, with permit figures for January-February half the value of those of a year ago. Unemployment in eleven Western states worst in last three years, with seasonal improvement now starting in Oregon and California.



Seattle—Unemployment 54 per cent worse than year ago.

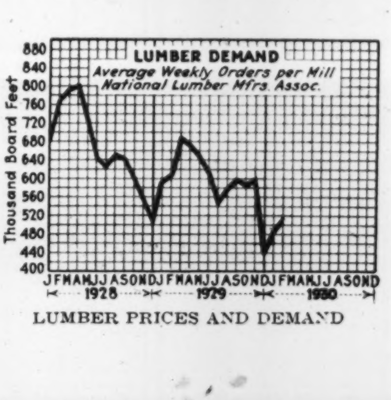
Los Angeles—Of 100,000, there are 40 per cent out, compared with 30 per cent last year.

Montreal—Of 40,000 unemployed, 24,000 are building trades mechanics.

Average Wages—Average rate for skilled labor is $1.37⅔ per hour, compared with $1.35⅓ a year ago. Common labor is 56.46c., compared with 52.9.

Materials Prices Not Weak

The weakness that has been evident in general wholesale commodity prices since November has not extended definitely to building materials. Among the latter there were declines in March in such miscellaneous items as road oils, railway ties, building paper, slaters' felt and reinforcing bars. On the other hand, there were increases in such important materials as cement, brick, tile, lime, gravel, linseed oil, steel sheets, and cast-iron and sewer pipe. Except for the possible stiffening effect of increasing construction volume, these ad-



LUMBER PRICES AND DEMAND

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**; declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor*
Atlanta	$1.25@1.40	$0.60@.70	$0.60@1.00	$0.50	....	$0.75@1.25	$0.25@.35
Baltimore	1.75	1.00@1.10	1.00@1.37½	....	....	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	....	1.25	.20@.35
Boston	1.50	1.37½	1.37½	.85	$1.27½	1.37½	.45@.80
Cincinnati	1.62½	1.40	1.40	1.00	1.40	1.40	.40@.60
Chicago	1.70	1.62½	1.62½	.97½	1.62½	1.62½	.97½
Cleveland	1.62	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	1.67½	1.12½	1.25	*.35*@.75	1.25	1.25	**.35**@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	....	1.25	.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	**.50**@.60
Kansas City	1.50	1.37½	1.25	.90	1.25	1.37½	*.35*@.75
Los Angeles	1.25	1.00	1.00	.62½@1.12½	.87½	1.00	.50
Minneapolis	1.25	.87½@.95	.87½	.75	....	1.00	.45@.60
Montreal	1.25	.80	.75	....	.90	1.00	.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.87½	1.65	1.92½	1.18¾	1.10@1.23¾	1.92½	1.03⅛
Philadelphia	1.75	1.50	1.02½	.70@1.12½	1.00	1.37½@1.50	.40@.50
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	....	1.50	.40@.80
St. Louis	1.75	1.50	1.60@1.75	1.15@1.25	*1.25*	1.62½	.40@.87½
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.68¾
Seattle	1.50	1.12½	1.12½@1.25	1.00	1.12½	1.25	.70

*Minimum rates are for construction other than buildings, non-union.

vances would be regarded only as temporary deviation from the down trend. The building materials index for February was 95.7, compared with 96.2 in January and 97.5 a year ago.

The price rise for cast-iron pipe is to meet a freight increase ordered for March 20 by the Interstate Commerce Commission against the wishes of the manufacturers and without solicitation by the railroads. The increase amounts to more than a dollar a ton for some municipalities. In New York and Pittsburgh it is 30c., bringing the price for 6-in. B to $39.90 and $45.80, respectively. In St. Louis it is $1.40, and the price is $44.

Freight increases have also been ordered on steel, effective May 20. The new rate will affect Boston, New York, Philadelphia, Buffalo, Cincinnati, Cleveland, Detroit, St. Louis, Chicago, Kansas City and Denver.

Increases early in March at four large cement mills in Pennsylvania, Ohio and Indiana have been followed by a recent 10c. advance to $1.80 at La Salle, Ill. Dealers' prices are up in Baltimore, St. Louis and Birmingham, and down in Boston and Atlanta. As an evidence of activity in the far South, the Tampa mill of the Florida Portland Cement Co. is operating at its full capacity for the first time since 1927.

To start municipal buying of season's requirements, road-oil producers tried a small advance in price, but without effect. The price is now a little lower in St. Louis and Dallas.

Recent heavy building awards in the New York district gave brick merchants their long waited opportunity to raise the price. April 1 the price was set at $15 delivered. Advances in other cities include $1 in Boston and $0.50 in Detroit and St. Louis. Declines: $2.50 in Atlanta, $1 in Birmingham and Cincinnati. Tile and small sewer pipe moved up.

The lumber market grows weaker, with prices wabbling and water freights increasing.

Demand for structural steel is light, but the price is unchanged. Only reinforcing bars have dropped, from $2 to $1.95. For steel sheets the independents plan to ask an advance of 10c., due to livelier inquiries for roofing and auto bodies.

Overstocks of sap-pine and cypress ties in St. Louis dropped the price 15c., to 85c., for 6x8x8 untreated. There have been small concessions also in birch and maple at Montreal and pine at New York.

The accompanying table gives the volume movements for the principal materials.

February Financing

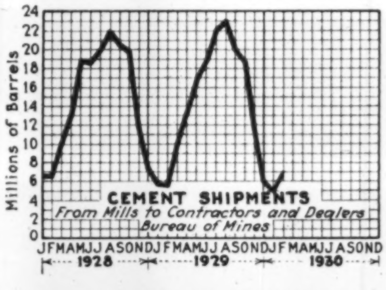
New capital issued in February totaled 621 millions, compared with 824 in January. Excluding foreign, and non-productive paper, the net was 463 millions, compared with 868 and 520 in February of 1929 and 1928. Municipal bonds aggregated 76 millions, compared with 68 and 130 in the other two years. Of the corporation issues, bonds amounted to 48 per cent, compared with 19 and 59 in February, 1929 and 1928. Railroad bond issues are unusually heavy, 104 millions. The heaviest issues are by public utilities, 163, and the second largest are those offered by manufacturing industries.

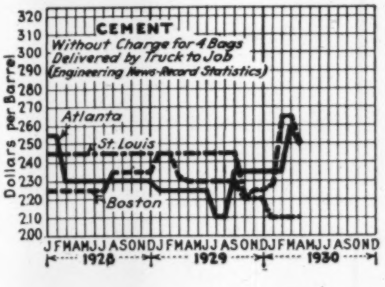
Among the important bond issues for capital expenditure are: $15,000,000 and $10,000,000 Morris & Essex R.R. at 96½ to yield 4.73 and 103½ to yield 4.76; $5,000,000 Bell Telephone 5s at 100; $1,850,000 South Pittsburgh Water at 93 to yield 5.47; $1,500,000 Sheffield Steel Corp. at 97½ to yield 5.72; $2,500,000 Fifth Ave. and 43rd St. Building at 94.6 to yield 6.75.

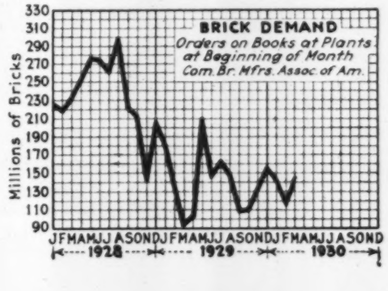
Announcement has just been made that the Northwest Mutual Life Insurance Co., of Milwaukee, is lending $12,000,000 at 5½ per cent on the Star Carew Building in Cincinnati for which steel is now being erected. This project is being handled by Starrett Brothers at Chicago.

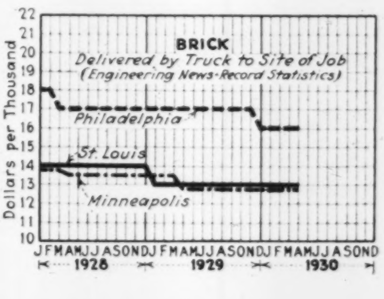
VOLUME MOVEMENT OF PRINCIPAL BUILDING MATERIALS

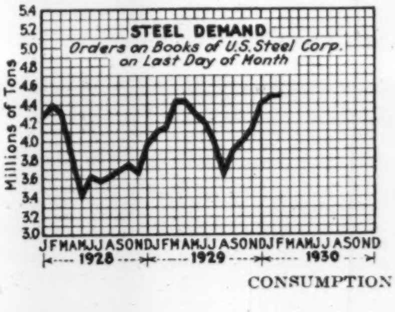
	Cumulative 1930	Cumulative 1929	Per Cent Change
Lumber, M. ft. b.m. (softwoods):			
Production, 12 weeks	2,993,861	3,357,942	—10.7
Shipments, 12 weeks	3,044,592	3,508,549	—13.1
Orders, 12 weeks	3,068,886	3,750,744	—18.4
Unfilled orders, 12 weeks	857,083	1,182,837	—27.4
Stocks, 12 weeks	2,950,580	2,606,050	+13.4
Cement, barrels:			
Production, 2 months	16,660,000	18,403,000	— 9.7
Shipments, 2 months	11,967,000	11,155,000	+ 7.2
Stocks, end of 2 months	28,231,000	29,870,000	— 5.3
Brick, common:			
Stocks, burned, March 1	513,057,000	366,150,000	+40.1
Shipments, 2 months	133,641,000	190,461,000	—30.0
Orders on books, March 1	140,451,000	91,615,000	+53.2
Steel, ingots:			
Production, tons, 2 months	7,854,290	8,816,354	—10.8
Fabricated structural steel:			
Orders, tons, 2 months	554,000	539,000	+ 0.9
Shipments, tons, 2 months	548,000	519,750	+ 5.5
Fabricated steel plate:			
Orders, tons, 2 months	77,269	91,489	—15.5
Porcelain plumbing fixtures:			
Orders, 2 months	17,051	24,946	—31.7
Shipments, 2 months	9,567	20,795	—54.0
Stocks, end 2 months	39,352	45,769	—14.0
Terra cotta:			
Orders, tons, 2 months	13,948	21,326	—34.7

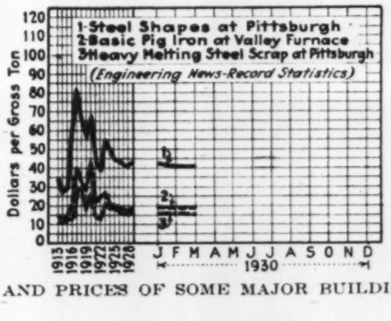


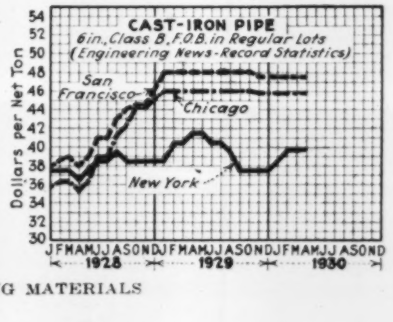












CONSUMPTION AND PRICES OF SOME MAJOR BUILDING MATERIALS

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per barrel, *without charge for bags*, cash discount not deducted. Prices marked f.o.b. are manufacturers'; others are delivered by truck to contractors:

	Apr. 3, 1930	One Mo. Ago	One Yr. Ago
Atlanta	*$2.49*	$2.60	$2.25
Baltimore	**2.60**	2.40	2.65
Birmingham	**2.60**	2.40	2.60
Boston	*2.50*	2.65	2.25@2.35
Dallas	2.15	2.15	2.15
Denver	2.61	2.61	2.55
Jersey City	2.60	2.60	2.60
Kansas City	2.65	2.65	2.22
Los Angeles	1.92	1.92	2.76
New Orleans	2.65	2.65	2.65
New York	2.30	2.30	2.25
Philadelphia	2.10	2.10	2.40
St. Louis	**2.45**	2.10	2.45
San Francisco	2.64	2.54	2.41
Seattle	2.70	2.70	2.70
(F.O.B.)			
Cedar Rapids	2.23	2.23	2.24
Chicago	1.95	1.95	2.05
Cincinnati	2.14	2.14	2.22
Cleveland	2.04	2.04	2.24
Davenport	2.14	2.14	2.24
Detroit	1.95	1.95	1.95
Duluth	2.04	2.04	2.04
Indianapolis	1.99	1.99	2.09
Milwaukee	2.10	2.10	2.20
Minneapolis	2.27	2.27	2.22
Montreal	2.05	2.05	1.70
Peoria	2.12	2.12	2.22
Pittsburgh	1.95	1.95	2.05
St. Paul	2.27	2.27	2.22
Toledo	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Limedale, Ind	$1.70
Buffington, Ind.	1.70	Mason City, Ia	1.85
Hannibal, Mo.	1.80	Norfolk, Va.	1.90
Houston, Tex	1.95	North Birmingham, Ala.	1.70
Hudson, N. Y	1.85	Richard City, Tenn	2.05
Ironton, Ohio	1.75	Steelton, Minn	1.85
Iola, Kan	1.85	Universal, Pa	1.70
La Salle, Ill	**1.80**	Wyandotte, Mich	1.70
Lehigh Valley District	1.75		

SAND AND GRAVEL—Per cu.yd., delivered by dealers. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds:

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta, per ton	*$2.60*	*$2.60*	*$2.15*
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb. per cu.yd.)	**3.50**	**3.50**	**3.00**
Boston, per ton	1.90	1.90	1.25
Chicago	1.90	1.90	1.80
Cincinnati, per ton	**1.75**	**1.75**	*1.50*
Cleveland (3,000 lb.) (2,700 lb.)	**2.70**	**2.70**	2.50
Dallas	2.60	2.60	2.60
Denver (2,700 lb. per cu.yd.)	1.80	1.80	1.30
Detroit (2,600 lb. per cu.yd.)	3.25	3.25	2.75
Kansas City, Mo.	....	....	....
Los Angeles, per ton	*1.40*	*1.40*	*1.00*
Minneapolis (2,800 lb.) (3,000 lb.)	2.40	2.40	1.10
Montreal, per ton	1.25	1.25	1.25
New Orleans (2,700 lb.) (2,500 lb.)	3.75	3.75	2.75
New York	3.40	3.40	2.15
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	2.20	2.20	2.40
St. Louis, per ton	2.25@2.35	2.25@2.35	2.00
San Francisco, per ton	1.75	1.75	1.75
Seattle (3,200 lb.) (2,850 lb.)	1.75	1.75	1.75

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Per cu.yd., delivered by dealers. Weight, 1½ tons per cu. yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	*$2.60*	*$2.60*
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.10	2.10
Chicago, Limestone (2,500 lb. per cu.yd.)	1.90	1.90
Cincinnati, per ton	2.25	2.25
Cleveland, per ton (2,500 lb. per cu.yd.)	2.70	2.70
Dallas (2,500 lb. per cu.yd.)	3.25	3.40
Denver, Granite (2,700 lb. per cu.yd.)	2.50	2.50
Detroit, Limestone, per ton (2,500 lb. per cu.yd.)	3.00	3.00
Kansas City, Limestone	2.50	2.50
Los Angeles, per ton	*1.50*	*1.50*
Minneapolis, Limestone (2,600 lb. per cu.yd.)	2.40	2.40
Montreal, per ton	1.90	2.10
New York, Limestone	3.40	3.40
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton, (2,400 lb. per cu.yd.)	1.90	1.90
San Francisco, Trap rock, per ton	1.65	1.65
Seattle, (2.700 lb. per cu.yd.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.35	1.35	.....	.80
Eastern Pa. and Northern N. J	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Building tile per block, delivered by dealers to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	*$0.069*	*$0.091*	*$0.125*	*$0.137*	*$0.178*
Baltimore	.105	....	.20	....	.26
Birmingham	.09	.127	.174	.218	.261
Boston	.086	.113	.155	**.21**	.26
Chicago	.076	.104	.142	.182	.202
Cincinnati	**.068**	**.095**	**.129**	**.165**	**.184**
Cleveland	.064	.088	.128	.171	.19
Dallas	**.094**	**.124**	**.194**	*.251*	.296
Denver	.0975	.135	.175	.2125	.25
Detroit	.098	.135	.184	.24	.265
Kansas City	.0525	.077	.184	.24	.265
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0611	.081	.10605	.1302	.1737
Montreal	.12*	....	.22†	....	....
New Orleans	.086	.118	.16	.212	.256
New York	.0864	.1296	.162	....	....
Perth Amboy, N.J. (f.o.b.)	..	....	....	.2388	.2956
Philadelphia	.105	.14	.215	.28	.34
Pittsburgh	.068	....	.1175	....	.1726
St. Louis	.078	.104	.145	.175	.21
San Francisco	.108	.156	.255	....	....
Seattle	.085	.115	.18	....	....

*4x4x12. †8x8x12

BRICK—Prices delivered by dealers per thousand, are as follows:

		Paving F.O.B.	
	Common	3x8½x4-in.	3½x8½x4-in
Atlanta	*$12.00*	$36.00*	$42.00†
Baltimore	13.00	40.00	46.00
Birmingham	*14.00*	26.00*	31.00†
Boston	**17.00**	43.00	47.00
Chicago	12.00	42.00	45.00
Cincinnati	*17.50*	*37.00*	*39.00*
Cleveland	14@16	33.00	36.00
Dallas	15.00	29.50*	.....
Denver	11.00	.....	.....
Detroit	**15.50**	33.50	36.50
Kansas City	14.00	.....	.....
Los Angeles	*9.00*	.....	.....
Minneapolis	12.75	.....	.....
Montreal	20.00	.....	.....
New Orleans	16.50	38.00*	45.00
New York	**15.00**	45.00	50.00
Philadelphia	16.00	40.00	46.00
Pittsburgh	16.00	40.50	45.00
St. Louis	**13.50**	40.00	40.00
San Francisco	14.50	45.00*	.....
Seattle	14.00	50.00	55.00

*2½x8½x4 in. †3x8½x4.

LIME—Prices delivered by dealers to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$21.00	$13.50	.....	......
Baltimore	22.00	14.00	$2.55†	......
Birmingham	22.00	16.00	3.00†	$2.00†
Boston	22.00	15.00	4.00*	**3.15***
Chicago	*17.00*	**14.50**	*15.00‡*	**1.50†**
Cincinnati	**15.80**	**13.00**	.....	......
Cleveland	**18.00**	**15.00**	2.50†	2.50†
Dallas	20.00	......	.....	1.85†
Denver	32.00	23.75	3.80*	3.00*
Detroit	*18.00*	14.80	2.20†	*2.00†*
Kansas City	**16.50**	**13.00**	**2.85†**	2.50†
Los Angeles	*18.90*	*16.00*	2.85†	*14.00‡*
Minneapolis	25.50	21.00	.....	1.70†
Montreal	19.75	.....	.....	15.00‡
New Orleans	.....	.....	2.60†	1.60†
New York	21.00	14.00	4.10*	3.15*
Philadelphia	22.00	15.00	.....	......
Pittsburgh	*20.00*	*18.00*	2.50†	.....
St. Louis	24.00	18.00	2.75†	15.00‡
San Francisco	20.00	20.00	2.00†	1.70†
Seattle, paper sacks	36.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@$0.20	Minneapolis	$0.15
Brooklyn and Queens	.12@.14	New Orleans	.22
Cleveland	.16@.17	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, f.o.b., quarry, Bangor, Pa., net, per square:

No. 1 Clear	$9.45@$13.05
No. 1 Ribbon	8.10@9.23
Medium Clear	8.55@10.13

Road and Paving Materials

PAVING STONE—Carloads or cargo lots of granite blocks, 4x8x4-in. dressed. f.o.b:

Atlanta	$3.00 per sq.yd
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.00 per sq.yd.
Minneapolis, 4½x8x5 in	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd	150.00 per M.
Philadelphia	125.00 per M
St. Louis, 4x5x8 to 12 in	3.50 per sq.yd

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Prices, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.25
Chicago	3½	12	2.10
Cincinnati	3½	16	2.35
Kansas City	3½	16	2.75
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	2.40
New York	3½	16	2.70
St. Louis	3½	16	**2.40**

FLAGGING—Alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft wide, 26c. per sq.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, 5x16 in., rough, 90c. per lin. ft., cutting charges extra *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16 in., f.o.b., $1.00 per lin.ft.; roundings, $1.50 per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in tank-car lots, f.o.b. points listed:

	Package	Tank-car
Atlanta (Mexican)	$20.40	$16.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	23.50	18.00
Chicago (Texas)	23.50	19.30
Cincinnati (Kentucky Rock)	....	12.30
Cleveland	24.00	20.00
Dallas (Texas)	*24.65*	....
Denver (California)	35.00	....
Detroit (Mexican) (Texas)	19.72	*14.87*
Kansas City, Mo. (Texas)	*30.00*	*25.00*
Los Angeles ("D" Grade, Calif., f.o.b., El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	....
Maurer, N. J. (Trinidad)	25.00	....
Minneapolis, (Stanolind, f.o.b., Twin Cities)	23.00	19.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	18.00	15.00
Pittsburgh (Standard Oil)	24@26	14@18
St. Louis (Venez.)	**22.50**	**18.50**
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, Calif., f.o.b. Richmond)	18.00	12.00

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	*.0525*
Dallas, 50@60% asphalt	*.0525*
New York, 40@50% asphalt. (at terminal)	.05
New York, 50@60% asphalt. (at terminal)	.05
St. Louis, 40@50% asphalt	*.04½*
St. Louis, 50@60% asphalt	*.04½*

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$15.00
Pittsburgh, basic, incl. freight ($1.76) from Valley	20.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	*3.65*	*3.65*
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b.	1.80	1.80
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.40	3.40

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.15@3.00
Cleveland, warehouse, delivered	2.25@2.44
Dallas, warehouse, delivered	*3.40*
New York, warehouse, delivered, over 5 tons	2.70
Pittsburgh, large mill lots, stock lengths, f.o.b.	*1.95*
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job, in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$18.50	$22.00	$20.50	$20.50	*$20.00*	$21.50
2.5	19.50	23.00	21.50	21.50	*23.00*	22.50
3.0	21.00	25.00	23.00	23.00	*25.00*	25.00
3.4	22.00	26.50	24.00	24.00	*28.00*	27.00

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and delivered by dealers, in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

				Warehouse Delivery			
Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.45	$1.13	$1.22
049	28	1.26	1.29	1.76	1.80	1.38	1.55
068	35	1.54	1.58	2.18	2.25	1.67	1.91
093	40	1.98	2.03	2.79	2.90	2.00	2.46
126	57	2.45	2.51	3.45	3.55	2.55	3.03
153	68	2.92	2.99	4.13	4.25	3.15	....
180	78	3.35	3.43	4.73	4.85	3.47	....

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base:

	Blue Annealed No. 10 *	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35†	$4.05†	$4.60†
Cleveland, warehouse, delivered	*3.25*	3.75	4.50
New York, warehouse, delivered	*3.60*†	3.90	4.50
Pittsburgh, large mill lots, f.o.b.	2.10	2.65	3.30
St. Louis, warehouse, delivered	3.45	4.25	4.85
San Francisco, warehouse, delivered	4.00	4.70	5.10

*Light plates †400 lb. to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
"Special Steel" and extra strong cast steel, round strand rope	27½%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, round-head, ¾-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	$4.00
Dallas, warehouse, delivered	*4.50*
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b.	3.10
St. Louis, warehouse, delivered	4.15
San Francisco, warehouse, delivered	*4.50*
Seattle, warehouse, delivered	4.25

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill:
Per package $10.70

SHIP SPIKES—Per 100 lb., black, from dealers' warehouse stocks; galvanised are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Per 100 lb. keg, base, delivered from warehouse stocks; also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St Louis	Dallas	San Francisco	Montreal
$2.30@$2.40	$3.30	**$2.85**	*$2.85*	$3.75	$3.25	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$11.50@$12.50	*$12.00@$12.50*	$12.50@$13.00
Stove plate	8.00@ 9.00	11.00@ 11.50	10.00
No. 1 machinery cast	10.85	14.00@ 14.50	12.00*
Machine shop turnings	7.00@ 7.50	**7.50@ 8.00**	8.25
Cast borings	7.00@ 7.50	*9.50@ 10.00*	9.50
Railroad malleable	*12.00@ 12.50*	16.50@ 17.00	13.00
Re-rolling rails	10.50@ 11.00	15.00@ 15.50	13.00
Re-laying rails, 56@60 lb.	23.00@ 24.00	20.00@ 24.00	....
Heavy melting steel, No. 1	10.50	*13.00@ 13.50*	12.25
Iron and steel pipe	9.25@ 9.75	9.00@ 9.50	9.50@10.00

*Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71†
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15*		

*Minimum weight on structurals, 60,000 lb. †Except iron or steel pipe and fittings.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34.00	34@36	34@36

RAILWAY TIES—For fair-sized orders, f.o.b., the following prices per tie hold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	*$1.25*
	Creosoted—prices on application.		
Birmingham	White oak, creosoted	1.52	1.75
	Southern pine, creosoted	1.25	1.60
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	*1.05*	*1.50*
	Red oak, creosoted	*1.40*	*1.90*
	Sap pine or cypress, untreated	*.85*	*1.20*
San Francisco	Douglas fir, green, untreated	.87½	1.21
	Douglas fir, empty cell, creosoted	1.60	2.10
Montreal	Birch or maple, untreated	.75	.75
	Birch or maple, creosoted	1.20	1.50

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb., f.o.b., Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, 9/16-in. and larger	$2.80	$3.55	$3.45	**$3.75@$3.85**	$4.35
Track bolts	3.80@4.00	4.55	5.85	**4.85@4.95**	5.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.75	.....	.....

Tie plates: Price at Pittsburgh mill, $2.07½ per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld Black	1 to 3-In. Butt Weld Galvanized	3½ to 6-In. Lap Weld Black	3½ to 6-In. Lap Weld Galvanized
Chicago, warehouse, delivered	55.5%	42.5%	51.6%	39.0%
Cleveland, warehouse, delivered	55.5%	43.5%	53.5%	40.5%
New York, warehouse, delivered	53.74%	41.2%	50.32%	37.78%
Pittsburgh, large mill lots, f.o.b.	62%	50.5%	59%	47.5%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$40.00@$41.00	$37.00@$38.00
Burlington (N. J.) mill	40.00	37.00
Chicago	48.20@49.20	45.20@46.20
New York	**42.90**	**39.90**
Pittsburgh	**48.80@49.80**	**45.80@46.80**
St. Louis	**47.00@48.00**	**44.00@45.00**
San Francisco	50.00@51.00	47.00@48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	**$0.16**	**$0.26**	*$0.46*	....	....	.....	....
Baltimore	....	.30	58	....	$1.93	.....	$6.50
Birmingham	.25	.40	65	$1.50	2.75	$3.90	5.83
Boston	185	.30	555	1.35	2.25	3.70	6.50
Chicago	.15@**.18**	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.135	.21	405	*1.05*	*1.89*	*3.456*	*5.4325*
Cleveland	**.189**	.294	.567	1.35	2.43	4.824	7.38
Dallas	.25	.375	.68	1.60	2.85	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52		1.90	3.80	.....
Los Angeles	.21	.2825	51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.85	3.49	4.97
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.195	.325	585	1.10	2.11	.....	.....
New York	.185	.29	56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	351	1.05	1.89	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.1645	.26	.468	1.092	1.872	3.65	4.80
San Francisco	1925	.275	495	1.155	1.98	3.30	4.95
Seattle	.22	.30	.54	1.26	2.16	3.50	.....

CLAY DRAIN TILE—Prices delivered by dealers, per 1,000 lin.ft.:

Size, In.	New York	Birm'ham	St Louis	Dallas	San Fran.	Seattle
4	$55.00	$56.00	$50.00	$63.00	$67.50	$60.00
6	112.00	112.00	85.00	100.00	112.50	112.00

Miscellaneous

LINSEED OIL—Raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York....**$0.15** Chicago....$0.154 Minneapolis..$0.159

WHITE AND RED LEAD—Base price per 100-lb. keg, f.o.b., New York: White, dry, $13.75; White, in oil, $14.25; Red, dry, $13.75; Red, in oil, $15.25.

CHEMICALS—Water, sewage treatment, road work, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	*$1.90@$2.00*
Sulphate of copper, in bbl., per 100 lb.	5.50@6.00
Soda ash, 58%, in bags, per 100 lb.	1.32@1.35
Chlorine, cylinders, per lb.	.04½@.06
Bleaching powder, in drums, f.o.b. works, per 100 lb.	2.00@2.10
Calcium chloride, in drums, f.o.b. works, per ton	22.75

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ½-in., 7-ft., 6-in.; ⅝-in., 6-ft, 1-in.; ¾-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1¼-in., 2-ft., 5-in.; 1½-in., 1-ft, 8-in. Following prices are quoted by dealers per pound for ¾-in. and larger:

Atlanta	$0.25	Kansas City	$0.25
Baltimore	.225	Los Angeles	.215
Birmingham	.26	Minneapolis	.23
Boston	.215	Montreal	.26
Chicago	*.21*	New Orleans	.25
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.23
Dallas	.20	San Francisco	**.215**
Denver	.24	Seattle	.215
Detroit	.23	St. Louis	**.275**

BUILDING PAPER—Black, in carloads, per roll of 500 sq.ft., f.o.b., producing point....*$2.00*

SLATERS FELT—In carloads, per roll, f.o.b., producing point....$0.77

ROOFING MATERIALS—Prices f.o.b., New York, delivered by dealers to contractors in carloads:

Asphalt felt, per 100 lb.	$2.60
Tar felt, per 100 lb.	2.60
Asphalt coating, per gal.	.34½
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFINGS—Prices delivered by dealers to contractors, in each loads, f.o.b. New York, per square:

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.12
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA..........83% A.........86% B..........88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.2225	.2450
Birmingham	.22	.245	Montreal	.20	.24
Boston	.22	.25	New Orleans	.195	.22
Chicago	.195*	.22*	New York	.255‡	.2775‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	**.20**	**.24**	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.155	.18
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

New York—Timbers, rough, delivered to contractor at site of job, in 20 ft. lengths and under, per M. ft., b.m.:

	Merchantable Long-leaf Yellow Pine	No. 1 Common Douglas Fir
3x4 to 8x8	$55.00	$39.00
3x10 to 10x10	65.00	40.00
3x12 to 12x12	75.00	42.00
3x14 to 14x14	87.50	50.00

Chicago—Prices, f.o.b., in carloads, No. 1 Common, rough, per M. ft. b.m. For delivery to job from stock, in truckloads, add $10 per M. ft., b.m:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$43.00	$42.00
3x10 to 10x10	50.50	42.00
3x12 to 12x12	62.50	42.00
3x14 to 14x14	74.50	43.00

San Francisco—Douglas fir, No. 1 common, rough, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft., b.m:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$33.00	$36.00
3x6 and 8	33.00	36.00
3x10 and 12	33.00	36.00
3x14	37.00	39.00

Other Cities—Delivered by dealers, No. 1 Common, rough, per M. ft., b.m:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$55.00	.....	.....	.....	$65.00	.....
Baltimore	36.00	$50.00	$53.50	$61.00	75.00	$50.25
Birmingham	53.00	.....	.....	.....	80.00	.....
Boston	**52.50**	*45.00*	47.00	48.00	60.00	*40.00*
Cincinnati	*47.50*	*58.50*	.....	.....	*65.00*	*52.50*
Cleveland	63.00	63.00	.....	.....	63.00	63.00
Dallas	55.00	57.50	55.00	55.00	*55.00*	55.00
Denver	.....	*47.50*	*47.50*	*47.50*	.....	*46.00*
•Detroit	55.00	53.00	.....	.....	68.50	53.00
Kansas City, Mo.	60.00	60.00	.....	.....	**67.50**	**68.00**
Los Angeles	.....	42.50	.....	.....	.....	44.50
•Minneapolis	58.00	52.25	38.25‡	.....	58@60	52.25
Montreal	.....	.....	.....	.....	56.00	48.00
New Orleans	52.00	48.00	.....	44.00	76.00	72.00
•Philadelphia	50.00	43.00	42.00	48.00	60.00	43.00
Pittsburgh	65.00	70.00	75.00	65.00	65.00	65@72
St. Louis	**48.00**	**43.00**	**43.00**	.....	**60.00**	**44.00**
Seattle	.....	*21.00*	.....	.....	.....	21@22

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$42.50	.....
Baltimore	56.00	$45.00	$44.00	.....	.....
Birmingham	36.00	.....	.....	45.00	.....
Boston	46.00	*40.00*	42.00	48.50	*$45.00*
Cincinnati	**61.00**	*52.50*	.....	*38.00*	*50.00*
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	*38.00*	*38.50*	.....	*44.00*
Detroit	47.50	45.00	.....	48.50	47.00
Kansas City, Mo.	*55.00*	*55.00*	.....	*48.00*	*48.00*
Los Angeles	.....	41.50	.....	.....	55.00
Minneapolis	53.00	46.00	39.75‡	51.00	45.00
Montreal	56.00	.....	.....	.....	.....
New Orleans	49.00	49.00	.....	59.00	55.00
Philadelphia	52.00	43.00	41.00	55.00	44.00
Pittsburgh	50.00	60.00	59.00	42.00	.....
St. Louis	**43.00**	**42.00**	**41.00**	**45.00**	**42.00**
Seattle	.....	**21.00**	.....	.....	*20.00*

*Long-leaf yellow pine. †Douglas fir. ‡F.o.b.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C., per lineal foot, pine, with bark on, f.o.b., New York; delivered from barge, 1¾ to 2c. per ft. additional:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.33	.41
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.38	.41

Unit Prices From Current Construction Bids

Reconstructing Twin City Lock at Minneapolis

AT THE close of 1929 the U. S. Engineer Office at St. Paul awarded contract to Northern States Contracting Co. (low among eleven bidders) for reconstructing the Twin City lock in the Mississippi at Minneapolis. The work includes a lower guide wall, lock gates, Stoney gate valves, gate- and valve-operating jacks and control valves. The principal element is the reconstruction of the lock to 400x56 ft. The river wall will be placed inside the wall of the old lock; the land wall will be removed and a double wall constructed for the new lock and for a future lock.

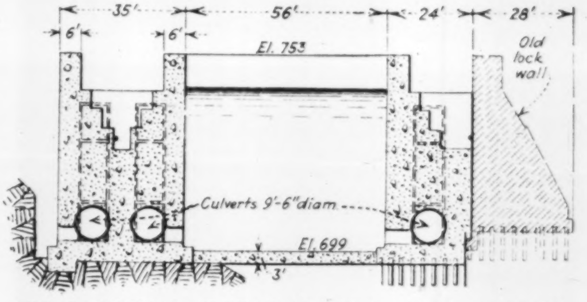


FIG. 2—TYPICAL SECTION OF RECONSTRUCTED LOCK

Unwatering the Site—Among the features that affected bidding are the following two: (1) incomplete data on existing structure; (2) presence in the riverbed of slip limestone and fissures. To help clear up these features, the United States constructed crib cofferdams above and below the lock, as shown in Fig. 1, to permit examination of the existing walls and the reconstruction of the entire lock except guide walls. Should the contractor decide to build his own cofferdams, he was permitted to use the material in these, but in any case he is responsible for their successful operation and ultimate removal. The steel piling remains government property. Payment for the cofferdams is based on inclusive lump sum bid. The contract bid was $37,800. The other bids averaged $71,200.

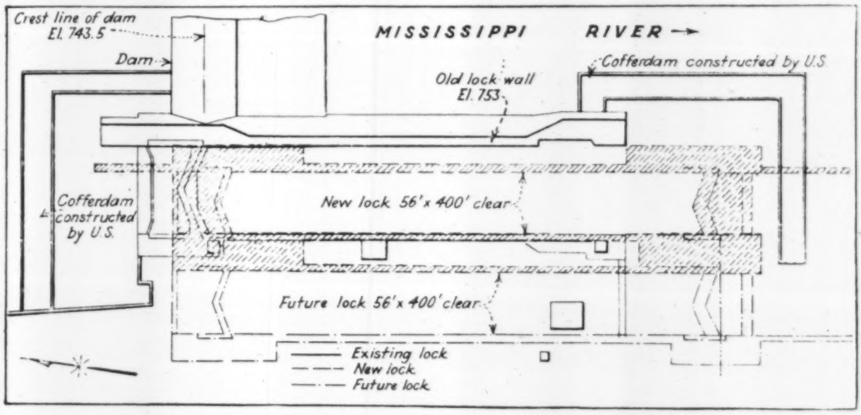


FIG. 1—PLAN OF RECONSTRUCTION OF TWIN CITY LOCK

The lock is on the edge of a sandstone ridge, the land wall of the old lock resting on the sandstone foundation and the river wall on piles to rock.

Excavation is classed as common or rock. Common includes all material above bedrock or shale, except boulders exceeding 9 cu.ft. or any material requiring blasting (which includes old lock masonry and floor). The existing upper gates and machinery become the property of the contractor.

Another feature affecting bidding was the fact that most of the spoil is wasted. The lowest three bidders for the whole job estimated $3.37, $2.60 and $1.60 for rock, and $1.06, $1.56 and $0.56 for common.

Concrete—The largest item is 64,100 cu.yd. of mass concrete, amounting to 54 per cent of the low bid. The low bidders for the job estimated $8.40, $8.32 and $9.40; the average for the eleven was $9.20. A cubic yard is composed of: (*a*) five bags cement (six for reinforced); (*b*) 25 lb. hydrated lime, 8½ lb diatomaceous silica, or an additional bag of cement, as the contractor prefers; (*c*) 25 cu.ft. coarse aggregate; (*d*) sufficient sand to yield 15 per cent more mortar than required to fill voids of aggregate; (*c*) sufficient water to make each batch a uniform plastic mass.

The mixing plant must have capacity for 300 cu.yd. in eight hours. Placing may be bucket, but not by tower. Before placing foundations and joints the surfaces are washed and scrubbed with steel brushes and roughened where necessary, and wet surfaces are covered with neat cement or 1½-in. mortar. Steel forms are permitted. All work is built in alternate monoliths not more than 42 ft. long. Top surfaces have a float finish without mortar. In all walls above the foundation course vertical expansion joints of 36-in. building tar paper are constructed between monoliths, as follows: below 40 deg. F., three thicknesses; 40 to 80 deg., two; above 80 deg., one.

Two other special features affected bidding: (1) limited storage area and difficult access to work; (2) completion within 250 days, with a penalty of $500 per day. The tabulation gives the prices of the lowest three bidders: (A) Northern States Contracting Co. (award); (B) Martin C. Wunderlich and H. C. Struchen; (C) Al. Johnson Construction Co.

	A	B	C
Cofferdam maintenance (lump sum)	$37,800.00	$47,000.00	$64,000.00
28,890 cu.yd. rock excav.	3.37	2.60	1.60
6,130 sq.ft. rock channeling	0.29	0.22	0.10
2,290 cu.yd. rockfill (crib)	0.75	1.04	1.00
1,380 cu.yd. protection stone	0.75	1.56	2.00
70,260 cu.yd. common excav.	1.06	1.56	0.56
18,000 cu.yd. fill	0.29	1.04	0.40
42,500 lin.ft. round piling	0.63	0.68	0.60
30,000 sq.ft. steel piling	1.37	1.52	1.60
64,100 cu.yd. conc. (mass)	8.40	7.765	9.40
350 cu.yd. conc. (reinf.)	19.00	8.32	20.00
220 cu.yd. conc. paving	16.00	9.75	10.00
1,344 ft. b.m. oak timber	300.00	90.00	300.00
89,800 ft. b.m. common timber	91.00	68.00	80.00
15,000 ft. b.m. select yellow pine	143.00	90.00	200.00
280 lin.ft. pipe, extra strong 2½ in.	8.70	1.76	1.50
830 lin.ft. pipe, extra strong 3 in.	5.17	2.20	2.00
1,220 lin.ft. pipe, extra strong 4 in.	4.40	4.00	3.00
50 lin.ft. pipe, std. 3 in.	1.26	1.00	1.50
1,235 lin.ft. pipe, std. 4 in.	2.15	2.92	2.00
1,500 lin.ft. conduit, 1½ in.	0.20	0.38	0.50
150 lin.ft. conduit, 1 in.	0.15	0.30	0.40
100 lin.ft. conduit, ¾ in.	0.11	0.24	0.30
600 lin.ft. drain tile	0.29	0.30	0.70
646,000 lb. structural steel	0.08	0.1055	0.08½
27,800 lb. steel forgings	11.69	0.15	0.13½
1,165 lb. nickel steel	0.24	0.50	0.47
164,000 lb. steel reinforcing rods	0.05	0.035	0.04¼
203,400 lb. steel castings	0.143	0.1487	0.13
8,100 lb. iron castings	0.11	0.125	0.12
15,000 lb. bolts	0.11	0.11	0.10
795 lb. bronze	0.60½	1.15	1.00
500 lin.ft. drilling anchor rod holes	0.93	0.20	1.00
1 lot Stoney gate valves	64,900.00	61,850.00	70,000.00
1 lot gate-operating machinery	17,650.00	17,304.00	17,300.00
Totals	$1,040,393.54	$1,040,625.29	$1,049,194.35

Unit Prices From Current Construction Bids

Weighted Average Unit Prices on Ten 1929 Road Projects in New Mexico, With Actual Prices on Three Jobs

(From *New Mexico Highway Journal*)

Item	Unit	F.A.P. No 76-A-Reo	F.A.P. No. 126-B	F.A.P. No 132-A	Average of Ten Projects
Clearing and grubbing	Acre				$25.00
Excavation (unclassified)	Cu.Yd.		$0.58	$0.95	0.44
Common excavation	Cu.Yd.	$0.19			0.32
Excavation (solid rock)	Cu.Yd.	1.25			1.25
Excavation for structures	Cu.Yd.		2.00	1.40	1.26
Excavation for bank protection	Cu.Yd.				1.00
Borrow (unclassified)	Cu.Yd.		0.24		0.24
Common borrow	Cu.Yd.	0.18		0.28	0.24
Overhaul	Sta. Yd.	0.03	0.03	0.03	0.03
Overhaul	Mile Yd.			1.00	1.00
Scarify and reshape surf. course	Mile	50.00		50.00	52.50
Surface plating course	Cu.Yd.				0.31
Crushed gravel base course	Cu.Yd.			1.45	1.67
Base course for oil proc. surf.	Cu.Yd.	1.50		1.45	1.46
Binder	Cu.Yd.	0.75			0.71
Binder (bridges)	Cu.Yd.	1.00			0.65
Cr. selected material wear, top.	Cu.Yd.		2.50		2.50
Cr. selected material surfacing,	Cu.Yd.		2.45		1.72
Cr. selected material base	Cu.Yd.	2.00			2.00
Cl. "A" conc. box culv. and siph.	Cu.Yd.	25.00	22.00	20.25	23.29
Cl. "B" con. mtl. clv. pipe hdw.	Cu.Yd.			24.00	22.33
Cl. "D" concrete superstructure	Cu.Yd.				25.00
Cl. "A" concrete substructure	Cu.Yd.		22.00	19.25	21.15
Cl. "A" concrete superstructure	Cu.Yd.			21.25	21.25
Reinforcing steel (bridge)	Pound		0.06	0.043	0.057
Reinf. steel conc. culv. and siph.	Pound	0.06	0.06	0.055	0.059
Reinf. steel h'dwl. and sp'ways	Pound		0.06	0.07	0.063
Structural steel	Pound		0.10	0.048	0.061
Struc. steel (bolts, angles, etc.)	Pound				0.08
Mortar rubble masonry	Cu.Yd.	8.50	7.00		7.83
18 in. galv. C. M. culverts	Lin.Ft.	2.00			2.00
24 in. galv. C. M. culverts	Lin.Ft.	2.50	3.00	3.35	2.92
30 in. galv. C. M. culverts	Lin.Ft.	3.25	3.85		3.73
36 in. glav. C. M. culverts	Lin.Ft.	5.75	5.50		5.42
18 in. P. I. galv. C. M. culverts.	Lin.Ft.	2.50			2.50
24 in. P. I. galv. C. M. culverts.	Lin.Ft.	3.00			3.00
30 in. P. I. galv. C. M. culverts.	Lin.Ft.	4.00			4.00
36 in. P. I. galv. C. M. culverts.	Lin.Ft.	6.50			6.50
Woven wire guard fence	Lin.Ft.		1.00	1.10	1.00
Woven wire bridge railing	Lin.Ft.	0.75	1.00	1.00	1.04
Galv. barbed wire fence	Lin.Ft.	055	0.06	0.04¾	0.053
Reconstructed fence	Lin.Ft.			0.03	0.026
Gates	Each	18.00	15.00	16.00	17.50
Cattle guard	Each				675.00
Treated timber superstructure	M.B.M.	130.00	150.00	133.00	138.50
Treated timber substructure	M.B.M.	130.00		133.00	137.66
Treated timber piling	Lin.Ft.	1.50		1.35	1.54
Protection ditch and dike	Lin.Ft.		0.05		0.05
Piling bank protection	Lin.Ft	1.50			1.37
Wire bank protection (fabric)	Pound	0.15			0.13
Brush and rock bank protection	Cu.Yd.	2.50			3.25
Conc. monuments and markets	Each	25.00	10.00	15.00	15.00
Riprap	Sq.Yd.		2.00		1.37
Cl. "B" concrete spillway	Cu.Yd.		25.00		21.75
Concrete pavement spillway	Sq.Yd.		2.75		3.05
Fabric reinforcement spillway	Sq.Yd.		0.05		0.05
Rockfill	Cu.Yd.			1.50	1.50
Approach fill (U abutment)	Cu.Yd.			0.60	0.60
Finishing earth graded roads	Sta.				1.00

Grading and Drainage for Mount Vernon Highway (D. C. and Va.)

BIDS were asked Jan. 23, 1930, for Unit 2 of the Mount Vernon Memorial Highway, and contract has been awarded to the lowest bidder. Unit 2 begins on Columbia Island in the Potomac River, at a point approximately 1,300 ft. south of the center line of the Arlington Memorial Bridge Plaza, and extends to the entrance gate of Mount Vernon, being located partly in the District of Columbia, partly in Alexandria, and partly in Arlington and Fairfax counties, Va. The work consists of grading, drainage and incidental construction. Alternate bids were asked for vitrified clay pipe, in place of concrete culvert pipe, for all of the several sizes, from 8-in. to 24-in., and the contract calls for vitrified.

A special element of the project consists of 186,850 cu.yd. of "special borrow," for the construction of a 1,200-ft. fill across Little Hunting Creek; for all items of regular borrow, the location of pit is specified and the necessary rights-of-way are provided by the government. Because of the possibility of obtaining material from the bed of the Potomac for the Little Hunting Creek fill, this item was designated as special borrow, and the contractor is required to furnish the material from his own borrowpits. The right was reserved to let the work as a single contract, including the special borrow, or to award the latter as a separate contract. The contract was awarded on the latter basis. Proposals for the special borrow item will probably not be invited until the bridge across Little Hunting Creek is completed, next fall.

Bids were submitted by 25 contractors in 20 cities. Excluding the special borrow item, amounting to about a quarter of the cost, the contract price (by Vincent Schiavi, Buffalo) is $435,890.60, using vitrified pipe. His bid with concrete pipe was $440,740, a difference of 1 per cent. The second low bid, also with vitrified pipe, was only $269 above the contract price. These bidders, C. S. Luck & Sons & Albert Brothers, of Richmond and Salem, were the low bidders for the job, using concrete pipe, the figure being $438,114. The third low was $443,642, bidding only on vitrified pipe. The fourth bid was for concrete pipe only and was $446,771. The fifth low on the job, but the third contractor submitting bids on both concrete and vitrified pipe, was R. E. Durchee, Buffalo. The accompanying tabulation presents the principal contract unit prices, and those of the second bidder and of the third bidder to submit prices on both pipes. The work is being done under the direction of the Bureau of Public Roads, Washington. (A) Vincent Schiavi, Buffalo (awarded contract). (B) C. S. Luck & Sons, Inc., and Albert Bros., Inc., Richmond and Salem, Va. (C) R. E. Durchee, Buffalo.

Items of Work	Unit	Quantity	A Unit Price	B Unit Price	C Unit Price
Stripping and storing top soil	Cu.yd.	43,240	$0.40	$0.37	$0.35
Clearing and grubbing	Acre	106	220.00	100.00	150.00
Unclass. excav.	Cu.yd.	383,275	.35	.39	.35
Unclass. excav. for structures	Cu.yd.	5,020	2.50	1.50	1.50
Foundation fill	Cu.yd.	150	4.00	5.00	5.00
Pressure jetting of fills	Cu.yd.	131,570	.03	.03	.10
Unclass. excav. for borrow	Cu.yd.	132,365	35	.39	.35
Overhaul	Sta.yd.	2,363,770	.02	.02	.02
Finish. earth graded road	Mile	12,441	1,000.00	1,000.00	500.00
Gravel base course 8"	Sq.yd.	3,700	1.40	.60	60
Gravel base course 10"	Sq.yd.	1,720	1.50	.70	.75
Gravel surface course, 6"	Sq.yd.	3,880	1.30	.45	.50
Gravel surface course, 8"	Sq.yd.	2,300	1.35	.60	.60
Bituminous macadam surface	Sq.yd.	5,420	1.10	1.50	1.50
Class A concrete	Cu.yd.	1,950	18.00	21.00	25.00
Reinforcing steel	Lb	119,900	.05	.05	.06
Cement rubble masonry	Cu.yd.	90	15.00	20.00	30.00
Rubble forced concrete masonry	Cu.yd.	400	20.00	20.00	30.00
Dry rubble masonry	Cu.yd.	50	10.00	15.00	20.00
Concrete pipe, 8" dia.	Lin.ft.	1,680	1.00	50	1.50
Conc. pipe, 12" dia.	Lin.ft.	659	1.60	1.50	2.00
Conc. pipe, 15" dia.	Lin.ft.	225	2.20	2.00	2.50
Conc. pipe, 18" dia.	Lin.ft	283	2.60	2.75	3.00
Conc. pipe, 24" dia.	Lin.ft	4,848	3.50	3.50	3.50
Untreated timber piling	Lin.ft.	44,200	60	.60	1.10
Vitrified tile underdrain	Lin.ft.	5,775	90	1.50	1.25
Grouted rubble gutter	Sq.yd.	600	3.50	2.50	3.00
Concrete curb	Lin.ft.	1,500	1.00	1.50	1.50
Brick walks	Sq.ft.	860	3.50	3.00	4.00
Rustic guard rail	Lin.ft.	1,480	1.00	.50	1.50
Special borrow	Cu.yd.	186,850	78		
Total all items listed			$586,483.20		
Total all items except "special borrow"			440,740.20	$438,114.15	$465,461.15
Total "special borrow"			145,743.00		
Vitrified pipe, 8" dia.	Lin.ft.	1,680	30	.50	75
Vitrified pipe, 12" dia.	Lin.ft.	659	50	1.00	1.00
Vitrified pipe, 15" dia.	Lin.ft.	225	1.00	1.75	1.50
Vitrified pipe, 18" dia.	Lin.ft.	283	1.70	2.35	2.00
Vitrified pipe, 24" dia.	Lin.ft.	4,848	3.00	3.20	3.00
Total vitrified pipe alternate	Lin.ft.		$16,083.60	$18,071.40	$17,366.50
Total concrete pipe items only	Lin.ft.		20,933.20	20,024.75	22,217.50
Total all items with vit. pipe alternate	Lin.ft.		581,633.60		
Total all items except "special borrow" with vit pipe alternate			$435,890.60	$436,160.80	$460,610.15